DISSERTATION

MORAL HAZARD IN HEALTH CARE:

CASE STUDY OF TAIWAN'S NATIONAL HEALTH INSURANCE

Submitted by

Chun-Wei Lin

Department of Economics

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Doctoral Committee:

Advisor: Chuen-Mei Fan

David Mushinski
Anita Alves Pena
John B. Loomis

ABSTRACT

MORAL HAZARD IN HEALTH CARE:

CASE STUDY OF TAIWAN'S NATIONAL HEALTH INSURANCE

My research examines the moral hazard phenomenon under Taiwan's National Health Insurance system theoretically as well as empirically. The objective is to investigate the effects of universal health insurance on individual lifestyle behavior such as smoking and alcohol consumption.

In the analytical section, I incorporate the individual's copayment rate, the premium, and the payroll tax rate in a moral-hazard model of national health care insurance plan. The two-stage for individual decision is applied to an extension of the moral hazard model originally proposed by Ehrlich and Becker (1972) and Stanciole (2007). In stage one, an individual moves first and decides his / her optimal unhealthy behavior before knowing the health status. In stage two, once the health status is revealed, he/she will move to choose the optimal amount of medical care after stage one. By applying the backward induction method, I show that after individuals falling sick in stage two, the optimal demand for medical service decreases when faced with a higher payroll tax rate, a higher copayment rate, a higher premium, and a higher medical service price. However, an individual's optimal demand for medical service increases with the individual's income level, poor health status and with the addiction of unhealthy behavior. In stage one, the individual's optimal unhealthy behaviors decrease with a higher copayment rate, a higher payroll tax rate, a higher premium, a higher medical price and with poor health status; but increase with income level. The effect from medical service is ambiguous.

I also examine how three government policy parameters –copayment rate, premium, and payroll tax rate – affect individual's welfare given his/her lifestyle under the universal health insurance system. My model results suggest that the copayment rate has an ambiguous effect on individual's well-being. Payroll tax rate and Premium have positive effects on the individual's well-being.

In my empirical investigation, I use two waves of the Health and Living Status of the Middle- Age and Elderly (SHLS) survey in Taiwan (1993 and 2007). Lifestyle behaviors (smoking and alcohol consumption) are employed as dependent variables. In my econometric model, I use a univariate *Probit* model and a seemingly unrelated bivariate *Probit* model to measure the determinants of unhealthy lifestyle behavior in 1993 and 2007. Two lifestyle behaviors – smoking and alcohol consumption – are employed as dependent variables in my model. Lastly, I apply a difference-in-difference (DD) methodology to compare how these effects change before and after implementation of Taiwan's national health insurance system. The result shows a lack of evidence in my data for the effect of national health insurance, implying no moral hazard effect is found under Taiwan's National Health Insurance.

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Dedication

In loving memory of my grandparents who are in heaven.

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Chapter 1 Introduction

1.1The moral hazard problem

Moral hazard refers to the effect of insurance on the behavior of the insured. In the health insurance context, moral hazard regards the likely misbehavior of an individual who has paid for insurance. Ehrlich and Becker (1972) is the first to propose a model to describe the different types of behavioral change, namely "ex-post moral hazard" and "ex-ante moral hazard". "Ex-post moral hazard", or "self-protection", describes the phenomenon in which the insured engage less in preventive behaviors or displaying less concern about their future health as the costs of treating illness are lower with insurance coverage, implying that the individuals will need more medical treatment in the future. This "self-protection" phenomenon may actually be bad for the individual's health. On the other hand, "ex-ante moral hazard", or "self-insurance", describes the phenomenon in which the uninsured have stronger incentives to engage in behaviors that prevent illness. For instance, people can exercise or eat healthy and avoid risky behaviors. This "self-insurance" phenomenon may have a positive effect on individual's health.

However, the other important part of health insurance is the moral hazard associated with the increased medical service utilization due to changing behaviors. For patients, if their care is subsidized by insurance or the government, they may demand a higher quantity of health service (patient's moral hazard). For providers, if they know that patients do not bear the full cost of services, they may increase the quantities of, and the price for treatments (doctor's moral hazard).

Abel-Smith (1992) also stated that the moral hazard problem has implications not only on insurance premiums and co-pays, but also for the cost of service provision. The ex-ante moral hazard problem arises due to the lack of monitoring of individual's healthy behavior, which they tend to reduce after joining the health insurance plan. The ex-post moral hazard problem arises due to over-consumption of medical services. The over-consumption may come from either the provider's or the patient's. "Over-consumption", as extended by Criel (1998), refers to treatment or services that could have been treated at a lower level (i.e., single X-ray vs. MRI) or not even requiring institution-based technical intervention (i.e., home rest vs. antibiotic treatment for common cold).

Cutler and Zeckhauser (p16, 2000) explains that moral hazard or hidden action emerges in the risks that individuals choose to take. People may not take good care of themselves when they have insurance, e.g., people consume more alcohol because they know that health insurance would cover the medical costs of liver cancer in the future. Zweifel and Manning (2000) also states that there are two different types of moral hazard: the first type is as individuals engage in more risky acts, the probability of needing medical service goes up; the second type is when individuals elicit more medical services after risky event happens.

In recent years, some research papers have focused on additional evidence of interaction between precautionary activities or health-related behaviors and health status. Balia and Jones (2005) found that lifestyle choices are important determinants of individual health. Choices like smoking or heavy drinking have harmful effects on health status and would increase probability of disease. Dave and Kaestner (2006) have found the effect of health insurance on health behaviors, arguing that there is a direct moral hazard effect for patients as well as a positive indirect effect for doctor visits under Medicare in the U.S. The positive indirect effect occurs when individuals schedule visit with doctors (by those would not have visited doctors without Medicare). This might improve health status and reduce the probability of illness. Preux (2010) also finds moral hazard effect on health-related behavior under universal (Medicare) coverage, showing that Medicare recipients are less likely to engage in healthy lifestyle (e.g. exercise).

1.2 Solving the moral hazard problem

Under mainstream health economics, there exist two asymmetric information properties of health service delivery that make health care different from other goods: (1) adverse selection and (2) moral hazard. Because of these properties, governments' efforts to efficiently provide health care services tend to encounter many problems. The problem of adverse selection was non-existent as of 1995 in Taiwan since everyone was eligible to enroll in the Taiwan National Health Insurance (NHI) program. Since the implementation of NHI by the Taiwanese Government in 1995, it is estimated that participation reached 99 percent of the total populations in 2010. However, the cost of financing NHI has increased in recent years resulting in a financial crisis. This can be mostly attributed to the problem of moral hazard.

The 1960s health economics literature used the term moral hazard to explain the problems with the status of health contracts, and pointed out that demand management can only partially solve the moral hazard problem as well as the corresponding market failure in health insurance. Culter and Zeckhauser (2000) stated that the moral hazard problem could be controlled by demand management (such as using co-payment) and supply management (such as using managed care) together.

In Taiwan's national health insurance system, the government (insurer) uses different incentives and mechanisms to control the increasing medical expenditure. The usual way to limit moral hazard is to require individuals to share a particular percentage of service, including the copayment, premium, and payroll tax. These three policy parameters are considered the most important devices of the NHI system. In addition, the Taiwanese government can also use some cost-control mechanisms such as utilizing review to manage medical cost. The conventional approach to discussing the moral hazard effects focuses on the relationship between health care spending and these policy parameters. That is, a higher copayment rate or payroll tax rate will cause lower medical service demand; on the other hand, a lower copayment rate or payroll tax rate will cause higher medical service demand. However, this approach can only address part of the moral hazard problem in medical service consumption.

There exist important relationships between precautionary activities (unhealthy behaviors) and the copayment rate, premium, or payroll tax rate. I argue that precautionary activities or health-related behaviors are key determinants in explaining the moral hazard phenomenon in health insurance content. This is based on the following reasons: The decision of whether a patient is hospitalized or not depends mostly on the doctor; the patient can only make a decision when the illness is not severe. A patient decides whether to go to the doctor or not based on their health status rather than on the copayment rate, premium, and payroll tax rate. If the patient engages in more healthy behaviors, then he / she may require less medical service. Therefore, precautionary activities or unhealthy behaviors are better variables in explaining the moral hazard phenomenon in my research.

My paper considers both health-related behaviors and medical service utilization, and investigates the direct insurance effects on lifestyle behaviors. In my paper, the direct effect of health insurance on individual's lifestyle behavior is referred to as "behavioral moral hazard".

Economists have employed the theory of choice under uncertainty to study why people choose to buy insurance coverage. The premise is to identify various environmental and personal characteristics as determinants of insurance purchase and to understand government policy and insurance market circumstances' effects on insurance purchase. The expected utility theory is particularly suitable for this analysis. This research measures the demand for medical services and compares the welfare of an individual under uncertainty. In addition, a risk-averse person who prefers certainty to risk will always purchase a good insurance plan. For instance, a person with a concave expected utility function prefers a small certain loss (pay the premium) to a large uncertain loss (accidental large medical expense).

1.3 Purpose of the Research

My research examines the moral hazard phenomenon under Taiwan's National Health Insurance system theoretically as well as empirically. The objective is to investigate the effects of universal health insurance on individual lifestyle behavior such as smoking and alcohol consumption.

I incorporate the patient's copayment rate, the premium, and the payroll tax rate in a moral-hazard model of national health care insurance plan. The two-stage for individual decision is applied to an extension of the moral hazard model originally proposed by Ehrlich and Becker (1972) and Stanciole (2007). In stage one, an individual moves first and decides his / her optimal unhealthy behavior before knowing the health status. In stage two, once the health status is revealed, he/she will move to choose the optimal amount of medical care after stage one.

I also examine how three government policy parameters – patient's copayment rate, premium, and payroll tax rate – affect individual's welfare given his/her lifestyle under the universal health insurance system. Finally, I empirically investigate the moral hazard effects based on my theoretical result. In my econometric model, I use an univariate *Probit* model and a seemingly unrelated bivariate *Probit* model. Two lifestyle behaviors – smoking and alcohol consumption –

are employed as dependent variables in my model. Then, I use a difference-in-difference (DD) methodology to compare how these effects change before and after implementation of Taiwan's national health insurance system. This research is intended to analyze the impact of public health insurance status on lifestyle behavior, and how this impact changes over time in response to the National Health Insurance reform of 1995. Data from a Taiwanese survey of the Health and Living Status of the Middle Aged and Elderly in 1993 and 2007 are used.

In Chapter 2, I will briefly review the evolution of the National Health Insurance System in Taiwan. Chapter 3 is a discussion of the theoretical and empirical literature on this topic. Chapter 4 sets the theoretical framework and analytical structure to highlight the moral hazard issue. Chapter 5 sets up the empirical econometric models for the impact of Taiwan's National Health Insurance system on lifestyle behavior. Chapter 6 interprets the empirical results of the econometric models. Chapter 7 is a summary and discussion of major findings, contributions, and future research directions.

Chapter 2. Overview of Taiwan's NHI System

2.1 Institutional Background

Taiwan is a small island measuring 36,000 km^2. Two-third of this island is mountainous with few populations, while the other one-third is heavily populated. In 2010, there were more than 24 million people with more than 50,000 physicians. Before March 1995, 67% of the total population of Taiwan had been covered by three major insurance programs (the Government Employee Insurance GEI, the Labor Insurance LI, and the Farmer's Health Insurance FHI, established in 1948, 1959 and 1989, respectively). Two of these major insurance schemes (the GEI and the FHI) ran under financial deficits for many years. In order to reform the health care system, Taiwan's government set up a planning committee to draft a universal health insurance plan called the National Health Insurance Program (Chiang, 1997). This draft was passed by the Congress of Taiwan in September 1994, known as The National Health Insurance Act of 1994. The Executive Yuan (executive branch of the Taiwanese government) decided to implement this universal health insurance program in March 1995, credited to both political pressure and social welfare considerations. It offered a comprehensive, unified, and universal health insurance program to all citizens and residents of Taiwan.

According to Taiwan's Bureau of National Health Insurance (BNHI, 2008), the government planned the NHI program to achieve two essential objectives: providing equal access to health care for all citizens and keeping total health spending at a reasonable level. Before the NHI was implemented, medical agencies made contracts separately with the three different social insurance programs. For example, those insured under the Labor Insurance (LI) could only gain access to medical care linked to LI, and they would find that the medicines and treatments provided were different from those under GEI or FHI. Doctors were required to ask which plan a patient participated in order to decide which treatment to offer. As Taiwan's Bureau of National Health Insurance (2004) stated, "NHI integrates the varied medical care benefits and all other social insurance systems into a unified system within which every enrollee's treatment is equal."

A wide range of health and medical care is provided by the government and private hospitals, and the NHI program offers comprehensive and equal benefit coverage to all its enrollees. The NHI benefits cover outpatient services in clinics and hospitals, inpatient care, Chinese medicine service, dental care, maternity care, physical therapy, preventive health care, home care, and rehabilitation for chronic mental illness. Preventive health care includes prenatal examinations for pregnant women, children's preventive health care, cervical PAP smear tests, and preventive health care examinations for adults. The scope of care services includes diagnosis testing, examination, consulting, surgery, drugs, supplies/devices, treatment, nursing care, and wards. However, cosmetic surgery, long-term care, dentures, hearing aid and prosthetics are not covered (BNHI, 2008), these items are paid by patients themselves in Taiwan.

NHI is a universal health insurance program which the entire population is eligible to enroll. Therefore, a fair share of risk-pooling and extensive collection of financial resources for NHI can be expected. All of the insured are provided with the right to equal opportunity of access to health care services. The following groups can enroll in NHI (BNHI, 2004):

1. All citizens who have established a registered domicile for at least 4 months in Taiwan.
2. Those individuals who do not have Taiwanese citizenship but have a Taiwanese Alien Residence Certificate (ARC).
3. Employees with specific employers must enroll in the NHI program as of their first workday.
4. Starting the 1st of February 2001, active military officers, non-commissioned officers, servicemen and military cadets were also included in the scope of NHI.

The goal of Taiwan's National Health Insurance reform was to establish an effective and socially affordable universal health insurance. However, before its implementation, the situation in Taiwan was very different. Before the NHI scheme, about 33 percent of the population in Taiwan did not have any health insurance coverage. After the implementation of National Health Insurance, with astounding speed, 99 percent of the total eligible population had enrolled, while 1 percent of the population did not enroll due to being abroad or in jail. Infants are covered under the program as soon as their births are registered at a local household registration office.

In sum, the objectives of the National Health Insurance program in Taiwan are (1) to provide universal coverage for Taiwan's entire population and equal-opportunity access for health and medical care; (2) to reduce personal financial burden and to maintain balanced budget and long-term operational viability for the government; and (3) to provide better quality medical care and better health for the population in Taiwan. These objectives are in line with what Feldstein (2006) has envisioned of a desirable system in (1) preventing the deprivation of care because of a patient's inability to pay; (2) avoiding wasteful spending; and (3) allowing care to reflect different tastes of individual patients.

2.1.1 Basic framework

Taiwan's National Health Insurance is a single-payer system. The three main components of the NHI system are the insured, the contracted healthcare providers and the Bureau of National Health Insurance (BNHI). The system works as follows: BNHI collects premiums from the insured and issues them insurance cards. Once the insured person uses the medical service, he/ she needs to pay a co-payment portion of the cost in cash and then the provider makes claim to BNHI for reimbursement of the rest of the medical service expense, as figure 2.1 explains:

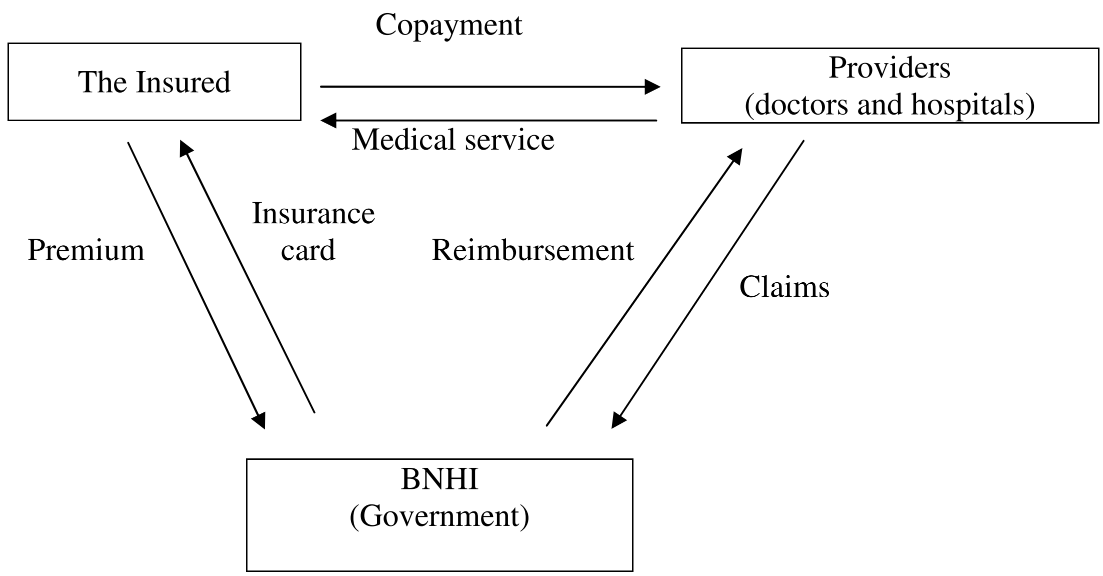


Fig.2.1 Framework of the National Health Insurance System in Taiwan

2.1.2 Co-payment

There was no co-payment requirement before the implementation of NHI, so moral hazard occurred frequently. In order to minimize moral hazard in the comprehensive universal health insurance program, NHI requires cost-sharing for outpatient and inpatient care, dental care, emergency care and Chinese medicine services and pharmaceuticals. However, co-payments are not required in certain situations. For example, if a beneficiary suffers a major illness or injury and requires long-term expensive treatment, the beneficiary is exempted from any co-payment obligation by Article 36 of the National Health Insurance Act (BNHI, 2008).

Co-payment exemptions have also been established for childbirth and preventive health services, low-income households, veterans and their dependents, and people residing in mountanous areas or on offshore islands. Social work departments, the Veterans Affairs Commission and the Bureau of Labor Insurance subsidize co-payments for the above groups (BNHI, 2008). The BNHI sets the copayment fee schedule to encourage patients to seek treatment for minor ailments at local clinic and district hospital while leaving regional hospital and medical center free to focus on more serious conditions. In addition, to prevent the public from incurring huge medical expenses, NHI has established co-payment ceilings. For each outpatient visit, in 2007, beneficiaries paid a fixed amount co-payment of NT$50 (USD$1.70) for clinic visits or outpatient visits to district hospitals. For outpatient visits to regional hospitals, the fixed amount co-payment is NT$140 (USD$4.80), and NT$210(USD$ 7.00) for outpatient visits to academic medical centers. Finally, the copayment for visiting dentists or traditional Chinese medicine practitioners is NT$50 (USD$1.70).

Table. 2.1, Basic Outpatient Care Copayment (NT $)

Type of Institution	Western Medical Outpatient Care	Emergency Care	Dental Care	Tradition Chinese Medicine
Medical Center	210	450	50	50
Regional Hospital	140	300	50	50
District Hospital	50	150	50	50
Clinic	50	150	50	50
Notes: Individuals classified as disabled pay a fixed copayment of NT$ 50 for all types of outpatient visits.				

Source: National Health Insurance in Taiwan, 2009. BNHI

For inpatient services, beneficiaries are required to pay co-payment for medical services as well as the cost of rooms and boards. Caps on copayment for inpatient care vary, ranging from 5% to 30% of patient's bill. Copayment rates are dependent on the length of stay and type of ward. For example, copayments on acute illnesses are 10% for the first 30 days, 20% for the next 30 days, and 30% for the 61st days and beyond (BNHI, 2009). Furthermore, in order to minimize inpatients' financial burden, copayment ceilings are adjusted annually, for example, in 2009, caps on the copayment of hospital stays were set at NT$30,000 for a single hospital stay and a cumulative NT$50,000 for the entire year. Overall, the co-payment rate is generally lower in Taiwan than in other countries, but it is could be binding for few people.

Table.2.2, Copayment rates for inpatient care

Ward	Copayment rate			
	5%	10%	20%	30%
Acute	-	30 days or less	31-60 days	61 days or above
Chronic	30 days or less	31-90 days	91-180 days	180 days or above

Source: National Health Insurance in Taiwan, 2009. BNHI

2.1.3 Premiums

The National Health Insurance program in Taiwan is funded primarily by a payroll tax system which the government referred to as a "premium" and is also supplemented by general tax revenue. For non-wage earners, their premiums are included in the premiums of a wage-earning family member. For those qualified for low-income status, their premiums are subsidized by the government. According to the National Health Insurance Law, NHI must be financially self-sustaining and the payroll tax should provide the funding of health expenditure. In 2007, premiums collected from the insured (38%) and employers (36%) constituted 74% of NHI revenues, and the remaining 26% was from government health care financing. The beneficiaries under the National Health Insurance scheme are classified into six subcategories, based on occupations (BNHI, 2008):

Category 1: Civil servants, employees of publicly or privately owned company.

Category 2: Self-employed/ Union Workers.

Category 3: Members of Farmers / Fishermen Association.

Category4: Military service members and their dependents.

Category 5: Low-income households.

Category 6: Veterans and their dependents.

Table. 2.3, NHI contribution ratio by insurance category, Bureau of National Health Insurance (BNHI, 2008)

<table>
<tr><th rowspan="2">Category</th><th rowspan="2" colspan="2">Classification of the Insured</th><th colspan="3">Contribution ratio (%)</th></tr>
<tr><th>Government</th><th>Employer</th><th>Insured</th></tr>
<tr><td rowspan="4">1</td><td>Private-sector employees</td><td rowspan="4">Insured and dependent</td><td>10</td><td>60</td><td>30</td></tr>
<tr><td>Government employees</td><td>-</td><td>70</td><td>30</td></tr>
<tr><td>Self-employed/employers</td><td>-</td><td>-</td><td>100</td></tr>
<tr><td>Private school faculty and staff</td><td>35</td><td>35</td><td>30</td></tr>
<tr><td>2</td><td>Union workers</td><td>Insured and dependent</td><td>40</td><td>-</td><td>60</td></tr>
<tr><td>3</td><td>Farmers/ Fishermen</td><td>Insured and dependent</td><td>70</td><td>-</td><td>30</td></tr>
<tr><td>4</td><td>Military service member</td><td>Insured and dependent</td><td>100</td><td>-</td><td>-</td></tr>
<tr><td>5</td><td>Low-income households</td><td>Insured and dependent</td><td>100</td><td>-</td><td>-</td></tr>
<tr><td rowspan="3">6</td><td rowspan="2">Veterans and their dependents</td><td>Insured</td><td>100</td><td>-</td><td>-</td></tr>
<tr><td>dependent</td><td>70</td><td>-</td><td>30</td></tr>
<tr><td>Other individuals</td><td>Insured and dependent</td><td>40</td><td>-</td><td>60</td></tr>
</table>

Based on the National Health Insurance Law, the premium rate (payroll tax rate in Taiwan) was set at 4.55% in 2007. However, from April 01, 2010, the rate was increased to 5.17%. Premium contributions are collected in two ways: (1) wage-based premiums paid by regular wage earners, and (2) fixed premiums paid by those without a well-defined monthly wage. However, the shares of contribution vary among insured groups (see Table 2-3 above).The premiums of the insured under categories 4, 5 and 6 are subsidized in full by the government. The premiums of all other insured are determined on the basis of their wages. Their premiums are shared or subsidized by the insured, the employer, and the government together. For public employees and their dependents, the insured and the government contribute 30% and 70% of the premium, respectively. For private employees and their dependents, the insured and the employer pay 30% and 60% of the premium, and the government subsidizes the remaining 10%. For the self-employed and their dependents as well as residents who do not fit into any of the above working groups, the insured pays 100% of the premium. For farmers, fishermen and veteran's dependents, the insured pays 30% and the government absorbs 70% of the premium.

The following formula is used by the Bureau of National Health Insurance to calculate individual, employer and government contribution to premiums in Taiwan's universal health system (BNHI, 2008, 2010):

(1)Premium Paid by the insured:

Premium= insurable wage× premium rate (5.17%) × **Insured's** share of premium × (1+ number of dependents)

(2)Premium Paid by the Employer:

Total employer contribution for a household= insurable wage × premium rate (5.17%) × **Employer's** share of premium × (1+ national average 4 number of dependents per insured household)

(3) Premium Paid by the Government:

Total government contribution for a household= insurable wage × premium rate (5.17%) × **Government's** share of premium × (1+ national average 4 number of dependents per insured household)

In order to relieve possible overwhelming financial pressure on large families, the government sets the maximum number of payable dependents at three. In addition, to prevent employers from discriminating against employees with large families, the calculation of employer contribution is based on a national average 4 number of dependents per household.

The comprehensive National Health Insurance benefit package has largely equalized people's financial access to health service. Most preventive services are free. Regular physician visits have a co-payment, and the co-payment rates are regressive because they are fixed at an amount (or a rate) and do not depend on the patient's income.

2.1Performance of Taiwan's National Health Insurance system

This section examines Taiwan's National Health Insurance on three aspects: NHI expenditure, equity, and medical quality improvement since 1995.

2.2.1The expenditure of NHI

The introduction of Taiwan's National Health Insurance System called for increased spending to improve the access and the quality of health care. However, due to financial and budget constraints, policymakers and hospital managers face escalating pressures to efficiently manage spending. The way to contain rising health care costs can be divided into macro- and micro- aspects. Most cost containment strategies approach the matter from the macro-aspect via public policy and regulation. Unfortunately, these types of solutions have not stopped health care expenditures from increasing. Therefore, many have looked at achieving cost containment at a micro level (i.e. direct cost control within hospitals).

Taiwan's total health care expenditure as a percentage of gross domestic product (GDP) can be seen in Table 2.4. It compares Taiwan's total health care expenditures with European and North American countries in 2005. The total healthcare expenditures as a percentage of GDP are between 7.4 % and 10.5% in Europe, 15% for the United States, 6.2% for Taiwan, and 5.6% for South Korea.

Table. 2.4 Taiwan's total healthcare expenditure as a % of GDP with other countries in 2005

Country	GDP	Healthcare expenditure		
	Million USD	Million USD	per capita (USD)	% of GDP
Denmark	211,928	19,050	3,534	9.0%
Finland	161,053	11,990	2,297	7.4%
France	1,799,413	117,314	2,967	10.1%
Iceland	10,570	1,108	3,827	10.5%
Netherlands	510,422	50,100	3,088	9.8%
Italy	1,461715	123,201	2,139	8.4%
Canada	857,199	84,543	2,670	9.9%
United States	10,951,300	1,683,700	5,635	15.0%
Taiwan	299,785	18,584	824	6.2%
Korea	605,354	33,736	705	5.6%

Source: Department of Health, Taiwan, 2006

Although health care expenditure in relation to GDP is lower in Taiwan than other developed countries, health care spending is still increasing. The rapid increase in medical expenditures has caused financial inbalance for the Bureau of National Health Insurance (BNHI).

The Bureau of National Health Insurance (BNHI, 2008) stated that the NHI system in recent years (2004 to 2006) has run deficits. If the situation does not improve, the government may have to raise premiums (payroll tax) or co-payments. Furthermore, the government may also have to cut the expenditure for health care to balance the budget.

2.2.2 Evaluation on Equity

The supply and the accessibility of medical services have improved during the last decade in Taiwan. Contracted medical resources have expanded faster than the increase in NHI enrollees, for example, the number of contracted physicians per 10,000 enrollees increased from 15.6 persons in 1995 to 21.8 persons in 2006. In addition, hospital beds per 10,000 enrollees also increased from 35.1 beds to 49.8 beds in that same period (Table 2.5).

Table 2.5. Medical Resources and Utilization in NHI of Taiwan: 1995, 1999, 2003, 2006

Items	1995	1999	2003	2006
Contracted Physicians (persons) [1]	29,913	39,709	45,282	49,107
Total outpatient care visits per month (thousand visits)	16,825	26,852	26,237	27,504
Outpatient service load per physician (visits per month)	562	676	579	560
Contracted Physicians per 10,000 enrollees (persons)	15.6	18.8	20.6	21.8
Contracted hospital beds (beds)	67,200	83,277	100,989	112,013
Total inpatient admissions per month (thousands)	160	216	228	243

[1] Including physicians in western medicine, Chinese medicine and dentists

Contracted inpatient beds per 10,000 enrollees (beds)	35.1	39.5	46	50

Data Source: National Health Insurance Annual Statistical Report, BNHI, 2007

In spite of the increasing in copayment rate, however, Chiang (2006) found that a moderate increase in copayment rate of 9 percent (of total medical expenses) between 1995 and 2006 did not discourage normal demand for medical services.

Cheng et al. (1999) and Cheng et al. (2002) analyzed the distribution of fiscal incidence in 1996 and 2000 across ten deciles of families (by different income groups), totaling 25,000 households with 92,689 enrollees. The results showed that from 1996 to 2000 the shares of fiscal burden from premiums and co-payments changed from 5.46 percent to 5.35 percent for the richest families and from 15.23 percent to 15.21 percent for the poorest families. They note therefore that the distribution of fiscal burden did not change much between 1996 and 2000.

The authors also found that the two richest deciles families paid almost twice the premiums and copayments compared to the two poorest deciles. This is much lower than the quintile ratio of the income share 6.00 for the same period. From the perspective of vertical equity, it seemed that the NHI system had quite a regressive distribution. Moreover, for the distribution of medical use, the share of medical expense was about 10 percent for every deciles family in 1996 and 2000, and not much difference was found in medical utilization among different income families. Finally, the result they found indicated that NHI medical benefits have reduced the fiscal burden for lower income families.

Chu et al. (2005) found that higher income households have larger out-of-pocket medical expenditures than lower income households. After the implementation of NHI, lower and middle income groups have had a relatively small decrease in medical expenditures. As for lower income groups, the NHI program led to a significant increase in utilization of health care.

2.2.3Evaluation on quality

Since the NHI was implemented, patients have been able to choose any hospital in Taiwan. This policy of selective contracting or freedom to choose has led to competition. To attract patients, hospitals increased the use of newer technologies and equipments as well as offering longer periods of stay in an effort to improve hospital quality. Cheng (2001) demonstrated the medical quality assurance measure as done through hospital evaluation. In accordance with their functions, hospitals in Taiwan are separated into three groups: medical centers, regional hospitals and district hospitals. The NHI adopts different fee schedules for the three types of hospitals. In addition, some benefit items (such as regular check-ups, maternity delivery, and rehabilitation) are regulated in that their services can only be provided by institutions with the appropriate certifications. In terms of treatment, it is very difficult to build a quantitative measurement for medical service. Nevertheless, the BNHI has set guideline for medical services providers to review.

An evaluation of the achievements of the NHI indicates that the expansion of insurance coverage has been a success. Improvements in the quality of health care (Table 2.6 and Fig.2.2) are reflected in a decrease in the morality rate, an increase in adjusted life expectancy, and high public satisfaction rates.

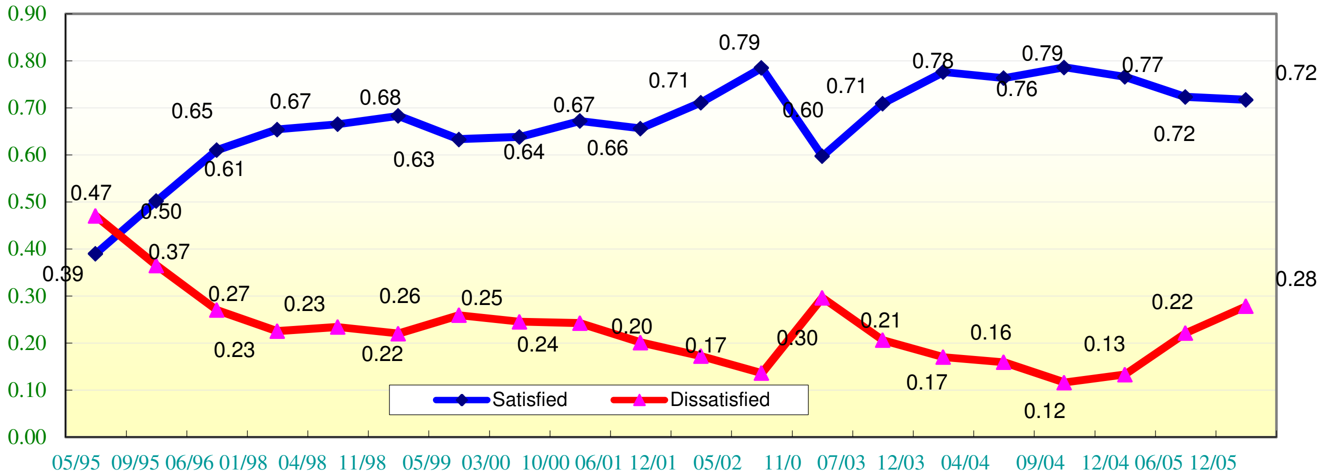
Table 2.6. Basic health care indicators: Taiwan, 1994, 1999, 2003, and 2007

Year	1994	1999	2003	2007
Basic Indicators				
Population (million)	21.0	21.6	22.5	22.9
Per capita GDP (US$)	12225	13566	13803	16724
Life expectancy (years)				
Male	71.8	72.5	74.7	75.4
Female	77.8	78.1	80.3	81.7
Infant mortality rate per 1000	8.8	7.1	6.8	4.9
Health Care Financing				
Per capita health spending (US$)	599	779	836	1015
Health spending as % of GDP	4.9	5.7	6.1	6.1
% of population insured	57	97	99	99

Source: from Department of Health and Ministry of Interior, Taiwan, 2008

From Table 2.6, we can compare basic health care indicators before and after the implementation of National Health Insurance in Taiwan. First, between 1994 and 2007 the life expectancies for men and women increased significantly: up 3.6 years for men and 2.9 years for women. In addition, Wen et al. (2008) examined the effects of NHI implementation by dividing the country into 10 groups and found that after the introduction of NHI, life expectancies improved substantially for the initially high mortality groups. During the decade before NHI, the gap between life expectancy for men in health group 1 (the healthiest) and group 10 (the least healthy) increased from 8.37 years to 10.65 years. During the decade after NHI, the gap between these two groups is decreased to 10.03 years. The 0.62 year existing gap suggested that Taiwan's national health insurance has indeed improved health outcomes and reduced the health disparity.

Fig. 2.2 Public satisfaction rates, Department of Health, Taiwan, 2006



The public satisfaction rate for Taiwan's health care system was at 33% in 1995 (Fig.2.2), it rose to 66.5% by the end of 1996, and then over 70% in 2005. Public dissatisfactions regarding services provided by medical institutions were focused on high premiums, co-payments and inadequate quality of care. The public's unfavorable opinion on health care service-providers were mainly related to the short duration of visits allowed in doctor's office and complaint about the quality of services.

Chiang (2006) reported that the number of annual outpatient visits per capita was 13.9 visits in 1996, rose to 15.4 visits in 1999, but then fell to 13.8 visits in 2004. It is still higher than the number of outpatient visits per capita in European and North American countries (average 6 visits). As for hospital admission, the number of admissions per 100 enrollees was about 12 during 1996-1998, but increased to 13 in 2004.

Cheng and Chiang (1997) evaluated the effect of Taiwan's NHI on health care utilization. They found that within the first year after the program was implemented, the utilization of health services among the newly insured group increased substantially. In addition, they also showed a small but statistically significant increase in outpatient visits (with about twice as many outpatient visits as they had when uninsured). One can argue that increased cost sharing did not seem helpful, if the aim was to lessen visits.

All in all, Taiwan's health insurance program has thus far removed some barriers to health care for those newly insured. However, the copayment design in the insurance scheme did not seem to significantly curb utilization. One issue that Taiwanese health care policy analysts should seriously consider is the continuous growth of health care expenditures since NHI's implementation.

Chapter 3 Literature review

In the health care context, ex ante moral hazard refers to the situation prior to the onset of illness, while ex post moral hazard comes into play once illness has already occurred. There is very limited empirical evidence to substantiate ex ante moral hazard in the form of a reduction of in preventative effort in response to health insurance coverage.

3.1 Theoretical studies

3.1.1 Insurance contract with first-order condition

In the 1960s, most moral hazard models took the constrained utility maximization approach. These models were enormously simplified since they investigated only the first-order condition in the comparative static framework. With the Lagrangian method, the moral hazard issue is particularly difficult to analyze. However, an extensive literature has been developed since then.

Arrow (1963) first analyzed the special economic problems of medical care by comparing the characteristics of the medical care industry with those of other industries. He treated the economic problems of medical care as identical choice under uncertainty with respect to the incidence of illness and the effectiveness of medical treatment. He described moral hazard as a problem of insurance and discussed the effect of insurance on incentives. Specifically, he examined an individual's incentive to consume additional health care services because of the reduced marginal cost for the patient the health insurance has provided.

Pauly (1968) argued that individuals covered by insurance are rational in seeking more health care services. He stated that the moral hazard problem has little to do with morality and should be analyzed by traditional economic tools, i.e., the moral hazard problem could be reduced most effectively by establishing and optimal set of deductibles and coinsurance.

The contributions of Arrow and Pauly have strongly influenced the development of the theory of moral hazard. From these two papers, many researchers and economists have attempted to expand the theory of moral hazard within the health care context.

The first formal model of moral hazard was that of Zeckhauser (1970) in which he discussed the choice of an insurance policy for medical expenditures, with solutions computed using first-order conditions. In addition, he suggested that the primary purpose of medical insurance is to spread the risk of incurring substantial medical expense. With risk spreading, individuals would not have to pay the full amount of expense. Insurance provision would introduce an incentive toward over-expenditure if the insured had substantial influence over the amount that is spent on their own behalf in any particular medical circumstance. The level of reimbursement by the insurance plan is positively related to the expenses incurred by the insured.

The papers above did no more than deriving first-order conditions for the general (linear) case. It was not until Blomqvist's (1997) paper, where the elasticity of demand for health services in excess of the necessary amount was used to determine the first- order condition in a non-linear model. The results he found suggested that the welfare losses from the government subsidy to employer-financed health insurance under the US tax system is smaller than previously estimated by using a linear model. In addition, Bajari et al. (2006) proposed a theoretical non-linear model based on Blomqvist (1997) to estimate a structural model of consumer demand for health insurance and medical utilization.

3.1.2 Demand for health care

Consumer uncertainty about illness and the associated losses will lead to a demand for health insurance. Because of the difficulty in knowing the exact nature of illness and the appropriate treatment, there is asymmetrical information between the consumer and the insurer, leading to moral hazard. People covered by health insurance may also affect the demand for health care because insurance distorts the effective price that people pay to obtain health services as a result people may overuse resources in medical care Manning et al. (1987).

Feldstein (1973) stated that demand for insurance is not the same as the demand for health care. Health insurance is purchased not as a final consumption good but as a means of paying for the future purchases of health services. In addition, people who have health insurance may affect the demand for health care. Grossman (1972) used a human capital approach to explain individual- level demand for health care. According to Grossman's theory, individuals invest in themselves through their own health in order to increase their earnings, they do not receive utility from medical services directly, but only through their positive effects on health. In Grossman's theoretical model, individuals derive utility from consumption, good health, and leisure. Health is determined by both medical inputs and lifestyle behaviors. Lifestyle inputs are measured by the amount of time spent on healthy behaviors such as exercise. Health insurance affects the individual's budget constraint by lowering the price of medical care. The individual faces a health shock every period that is realized after he makes his insurance decision, but before he chooses health inputs. For each period, an individual maximizes his lifetime utility by choosing the level of medical care and amount of time spent on lifestyle behaviors subject to a per period budget constraint and a time constraint.

Phelps (1973) stressed the simultaneity of the demand for health insurance and demand for health care. When purchasing insurance, the individual considers what effects that insurance will have on his demand for health care; and when actually buying health care, he or she considers the amount of insurance as a determinant of his actual medical service consumption.

Cameron et al. (1988) developed a model of joint decision by people to buy health insurance and medical care. The authors used a reduced form to estimate the demand for health insurance and stated that the structural parameters can be estimated by medical treatment decision.

Folland et al. (2004) found that health insurance might lead to excessive use of health care and the presence of insurance can also affect the probability of the event happening. An insured person may not make the same effort to prevent the illness as an uninsured person. Moral hazard occurs because the insurer cannot observe and monitor behaviors. Ehrlich and Chuma (1990), in their model of demand function of longevity (or quantity of life), showed that the demand for health and health care must be derived in conjunction with that for longevity and the related consumption plan, and all that choices depend on individual's initial endowment and different conditions. Their comparative dynamics predictions indicated that optimal health and longevity are increasing functions of endowed wealth, and that improvements in opportunities to produce health can accentuate the differences between the endowed wealth and the attained longevity levels.

3.1.3 Moral hazard and health insurance

Ehrlich and Becker (1972) developed a theory of demand for insurance that emphasized the interaction between insurance purchases in the marketplace, self-insurance, and self-protection, where self-insurance refers to efforts to reduce the size of prospective losses from fire, theft, war, and automobile accidents, given the probability distribution of the corresponding hazardous events. In contrast, self-protection refers to efforts to reduce the probabilities of unfavorable events, given the magnitudes of the corresponding prospective losses. The demand for market insurance is derived in conjunction with that for self-insurance and self-protection. They called the effect of market insurance on the demand for self-protection "moral hazard". They analyzed the effects of exogenous variables on insurance demand by using a state preference approach. Their analysis of moral hazard applied not only to the relationship between insurance and self-protection but also to the relationship between protection and insurance for all uncertainty events that can be influenced by human action. Kenkel (2000) stated that self-protection is often related to primary prevention – such as lifestyles and flu shot whereas self-insurance is associate with secondary prevention – such as check-ups and screening.

Shavell (1979) defined moral hazard as the tendency of insurance protection to alter an individual's motive to prevent loss, given that in general, the observation of care by the insurer is either impossible or too expensive. He defined a break- even policy (as one with zero expected profit) for the insurer as he maximizes his expected utility under moral hazard, and called it the optimal insurance policy. Then, the moral hazard problem is precisely the care that would be chosen by individuals and depend on the terms of the insurance policy.

Ehrlich (2000), and Ehrlich and Yin (2005) followed the analysis of optimal insurance and self-protection in Ehrlich and Becker (1972). These two papers treated life's end as uncertain and life expectancy as partly the product of individuals' efforts to self-protect against mortality and morbidity risks. When economists explore dimensions of consumer incentives in health care, they found that insurance is very important because it modifies the monetary price of medical care, the income of the insured, and the opportunity cost of time in the event of illness. The effect of insurance on health behavior and health care consumption is also referred to as "moral hazard". Folland et al. (2004) stated that moral hazard refers to the increasing use of services when the marginal costs for medical services decrease. They asserted that the degree of moral hazard depends on the elasticity of demand for health care service.

Health insurance involves a fundamental tradeoff between risk spending and moral hazard for the individual action (Zeckhsuser, 1970; Manning and Marquis, 1996). Zweifel et al. (2009) emphasized the optimal design of health insurance contracts in order to control for, or reduce moral hazard. Culter and Zeckhauser (2000) stated that the moral hazard problem could be controlled by demand management such as co-payment and supply management such as managed care. In addition, Osterkamp (2003) examined whether there is a way to reduce moral hazard in public health insurance systems by introducing a system of co-payment rate. He built a framework to discuss the possibility to reduce demand for medical service and achieve a Pareto-efficient improvement by changing the copayment rate. Blomqvist (1997) pointed out that making people pay more out-of-pocket for medical care can reduce overconsumption, and individuals paying higher coinsurance can increase the efficiency of health care provision. However, as people pay more out-of-pocket, they are exposed to more risk, which will reduce their welfare.

The above theoretical papers have shown how to use demand management mechanism (such as out-of-pocket or copayments) in order to reduce moral hazard. As for Taiwan's national health insurance system, I will incorporate the three government policy parameters - patient's copayment rate, individual's premium and the payroll tax into my theoretical moral-hazard model in order to examine the theoretical results of controlling the demand for medical service utilization, since government uses different incentive mechanisms to control the increasing total medical expenditure.

3.1.4 Health insurance and health related behavior

Most studies developed the health behavior theoretical moral hazard models by using constrained maximization and investigated only the first-order condition in the comparative static framework.

Manrique and Jensen (2004) assumed rational households seeking to maximize their satisfaction given their different preferences and budget constraints. For a household to achieve this, it first chooses to consume alcohol and/or tobacco. In a second step, the household decides the level of expenditures on these commodities. The result is a multiple choice combination for the demand functions of these goods – i.e., a household's behavior is different when it consumes both tobacco and alcoholic beverages compared to when it only consumes either tobacco or alcoholic beverages. However, Balia and Jones (2008) applied Grossman dynamic programming approach to examine the relationship between lifestyle behavior and health status. At the initial period the individual decides the optimal behavior to maximize lifetime utility. Thus, the future utility clearly depends upon past consumption decisions. Although their model (as well as in the Grossman's model) provided a maximized utility approach, but they did less discuss the uncertainty in the health investment model, which made it harder to distinguish the probability occurred on both preventive behavior and medical treatment.

Klick and Stratman (2004) modeled a diabetic's behavior involving unhealthy food choice. They found that as the cost of medical treatments declines, the diabetic individual will consume more unhealthful food, suggesting that mandatory insurance coverage may actually produce adverse health effects. Dave and Kaestner (2006) studied a straightforward application of Ehrilich and Becker's (1972) model of the demand for self-prevention using a maximum expected utility model. They also introduced health insurance (Medicare) as an exogenous variable into their theoretical model in order to analyze the effects of Medicare on preventive behavior. The theoretical results showed that health insurance not only has a negative and direct moral hazard effect on health behavior, but also an indirect effect of increasing preventative behavior via increased doctor visitation. This theoretical result for doctor's indirect effect is important evidence toward changing preventative behavior.

Bhattacharya and Sood (2005) developed a model of body weight choice to examine the health insurance externality by a utility model. They assumed that in the first step, individuals decided how much weight to lose. Weight loss via exercising initially generates disutility but it also improves health status. In the second stage, a health shock occurs which requires a determination on the amount of medical expenditure. The individual's problem is to maximize his or her expected utility by choosing the amount of weight to lose and medical consumption jointly. This body weight model is also viewed as a Cournot model, as it solves two optimal choices (body weight and medical consumption) simultaneously.

Stanciole's (2007) theoretical framework used an extension of the models proposed by Ehrlich and Becker (1972) and Zweifel and Breyer (1997). The consumer makes the following two choices simultaneously. First, the individual decides whether to buy insurance coverage. Second, he/she engages in a risky behavior, which corresponds to the lifestyle choices of smoking, drinking, and exercising. The author assumed that above two decisions are correlated. By maximizing expected utility function under the budget constraint, he considers two different methods to solve the optimal lifestyle choice based on the types of premiums: (1) risk related premiums- using a Cournot model to find the optimal lifestyle behavior, in which risk related premium do mitigate moral hazard, and (2) uniformed premiums - using two stages method, first the decision to engage in the risky behavior and then the individual decides how much insurance coverage to contract by considering the lifestyle chosen in the first stage.

Preux (2010) developed a theoretical model introduced by Ehrlich & Becker (1972) and modified their framework by taking into account (1) the benefit of healthy lifestyle and (2) the anticipated insurance coverage. The author proposed a simple model where the individual maximizes expected utility by choosing her investment in health related behavior to explain how insurance coverage influence lifestyle behavior. In this paper, individuals who have an incentive to reduce their preventive efforts before receiving Medicare are terms of "ex-anti moral hazard with anticipatory behavior". Finally, in the case of Medicare, the theoretical result showed that individuals reduce their investment in healthy lifestyles as they get to closer to the age of 65.

Above three researches (Bhattacharya and Sood, 2005; Stanciole, 2007; and Preux, 2010) are all maximizing expected utility function under the budget constraint by applying the Cournot model, but Cournot model - it only solves two optimal choices simultaneously. The shortcoming for Cournot model is failed to examine the interaction effects between these two optimal choices.

In my theoretical model, the two-stage for individual decision is applied to an extension of the moral hazard model originally proposed by Ehrlich and Becker (1972) and Stanciole (2007). With constrained maximization, in stage one, individuals move first and decide their optimal unhealthy behavior before knowing their health status. In stage two, once the health status is revealed, they will move next to choose the optimal amount of medical care. In my two-stage method, I can show the interaction effects between optimal lifestyle choice and optimal medical service consumption, which means that I not only discuss how the lifestyle choice affects optimal medical care service, but I also examine how medical services affects optimal lifestyle choice.

3.1.5 Public health insurance and social welfare

Felstein (1977) stated that national public health insurance may be used to counter the moral hazard problem by a comprehensive major-risk insurance (MRI) policy that sets a limit on out-of-pocket payments. Akerlof (1970) developed a formal model with the market for used cars (lemons) as an example to predict that compulsory insurance can improve welfare. Feldman et al. (1998) analyzed whether government intervention can improve consumer welfare. They imposed a government budget constraint that insurance policies designed by the government must break even. They found that the government could always improve consumer welfare in the model by pumping more public funds into the insurance system.

Zweifel et al. (2009, p.176) stated that if risks of illness are heterogeneous and not observable to the insurer, and individuals are allowed to buy supplementary health insurance, the introduction of compulsory insurance may result in a Pareto improvement. Because high-risk types would benefit from the subsidization in the public insurance scheme, while low-risk types are better off due to the rational restriction. Besley (1989) stated that public health insurance may play a role in an combating moral hazard and showed how government intervention in insurance market can enhance welfare. Welfare improvement occurs because public health insurance encourages insured individuals to cut down the premium burden of private insurance. Therefore, the insured individuals would be better off. Hansen and Keiding (2002) showed a simple model of compulsory health insurance with adverse selection condition in which individuals with compulsory insurance will not be better off than those in a competitive market condition (in which some risky individuals are uninsured) when measured by average utility.

Bhattacharya and Sood (2005) showed the deadweight loss in social welfare from the obesity externality. Their results revealed that if individual weight choice does not respond to health insurance, then the deadweight loss would be zero, implying that the public insurance plan actually causes social welfare loss.

Moral hazard is a major concern in insurance policy with government intervention as an argument. Under a national health insurance system such as Taiwan's, the government insurance policy may enhance social welfare if the government is able to control the policy parameters appropriately. In my paper, I follow Besley (1989) concepts to examine whether government intervention enhances individual well-being welfare or not. I assume that Taiwanese government's objective is to choose patient's copayment rate, individual's premium, and payroll tax rate in order to maximize individual's well-being given individual's optimal lifestyle behavior. With respect to these three government parameters, I consider the effects of an individual's well-being improvement to examine the extent of government control of the moral hazard under the Taiwan's NHI system.

3.2 Empirical studies

In the past few decades, many studies have investigated the effects of health insurance on health care consumption. Most of these studies analyzed the conventional moral hazard problem of the relationship between health care consumption and health insurance. However, few have examined the moral hazard effect on lifestyle behavior in the past decade.

3.2.1The impact of health insurance on the medical service utilization

Substantial literature in the 1970s such as Feldstein (1971), Phelps and Newhouse (1974), Rosett and Huang (1973), and Newhouse and Phelps (1976), have estimated the price elasticity of demand for medical service. Their results showed that the price elasticity was between -0.1 and -1.5. After these early papers, the federal government started the RAND Health Insurance Experiment in 1974. The experiment was a randomized study of nearly 6,000 people in six areas with different insurance plans over a three to five years period. In part, it used randomization to account for health status, income, and other factors. Elasticity estimates were formed from cost sharing (coinsurance rate) by comparing utilization in different plans. Manning et al. (1987) studied the impact of insurance on the demand for health services using the RAND Health Insurance Experiment (RHIE). The greatest advantage of the RHIE relative to subsequent studies is the randomization of the insurance type across individuals. A randomized control trial approach establishes the exogeneity of the insurance status and allows the identification of the increase in health service utilization with moral hazard.

Manning and Marquis (1996) estimated optimal health insurance coverage, which involved a trade-off between the gain from risk reduction and the welfare loss from moral hazard using the RAND Health Insurance Experiment. This paper examined this tradeoff empirically by estimating both the demand for health insurance and the demand for health services. Their finding suggested that the demand for health care is closely related to price and income with elasticities of -0.18 and +0.22, respectively.

To sum up, the RAND Experiment found an overall medical care price elasticity of about -0.2. In addition, the demand elasticity in the RAND Experiment has become the standard in the literature, and most economists have accepted that traditional health insurance leads to moderate moral hazard in demand for medical service.

There were also studies that investigated the impact of extra health insurance coverage on medical service utilization in some developed countries, revealing evidence for moral hazard in the health care market. In the United States, Lichenberg (2002) and Meer and Rosen (2004) have found evidence for moral hazard. Cameron et al. (1988) conducted similar study in Australia, while Holly et al. (1998) in Switzerland, Vera-Hern'andez (1999) in Span, Chiappori et al. (1998) in France, and recently Barros et al. (2008) in Portugal.

In Taiwan, several studies have examined the effect of universal health care on the utilization of medical services. Cheng and Chiang (1997), Hsieh and Lin (1997) and Chi and Shin (1999) evaluated the effect of Taiwan's national health insurance on health care utilization before and after Taiwan's NHI program. They showed that elderly with good health condition were less likely to use medical services, compared to bad condition. People with a higher educational level also had a lower probability to use medical services. Overall, these studies suggest that national health insurance increases the demand for formal medical services.

Chen, et al. (2007), Chen, et al. (2007) and Chi et al. (2008) tested the utilization of preventative care service and found that it has reduced medical service utilization of Taiwan's

National Health Insurance (NHI). These papers also found the NHI to be associated with a statistically significant increase in the demand for medical service among the elderly and infants.

3.2.2 Health related behavior and health insurance

Preux (2010) stated that ex-ante moral hazard (EAMH) is the reduction in preventive effort due to health insurance coverage. Stanciole (2007) also showed that health insurance has incentive effects on lifestyle choices. There are several studies examining health related behaviors and health insurance. Some empirical evidence is supportive of the existence of a moral hazard effect on lifestyle behaviors.

Newhouse (1993) examined the differences in levels of physical activity, smoking and alcohol consumption, among individuals enrolled in cost-sharing insurance plans and free plans by using data from the RAND Health Insurance Experiment (RHIE). The result showed that less comprehensive health insurance had no significant or practical effect on behaviors such as smoking, alcohol consumption, and exercise.

Kenkel (1995) used the health production function framework to analyze the determinants of lifestyles behavior on health. He found being overweight, cigarette smoking, heavy drinking, and stress to be harmful inputs in the health production function, but regular exercise and moderate alcohol consumption are beneficial health inputs. Moreover, Kenkel (2000) examined the effect of health insurance on some of the preventive behaviors by using the data of the National Health Interview Survey. He found little evidence of a moral hazard effect of insurance in his analysis of individual behaviors. He found that men who are insured were more likely to be obese. Additionally, he concluded that people who have insurance are more likely to engage in health promoting behaviors than those without insurance. However, his analysis may be biased because he did not consider the possibility of a reverse causality between insurance status and preventive behaviors.

Khwaja (2002) developed a dynamic stochastic model of individual choice about health insurance, exercise, smoking, alcohol consumption and medical treatment to estimate the different health policy experiments. The finding suggested that provision of subsidized medical treatment led to increased demand for medical care but also promoted healthy behaviors. Klick and Stratman (2004) examined the health effects of diabetes by focusing on individuals' body mass indexes (BMIs) from 1996 to 2000. They analyzed individual- level data from the Behavioral Risk Factor Surveillance System (BRFSS) by employing a triple-differences research design. Their controls include year variables (1998 or later), an adopt mandates insurance variable, and a diabetic variable. The coefficient of three interaction term is capturing the effect of the mandate on a mandate-state diabetic; meaning that this compares the change in the BMI gap between diabetics and non-diabetics. Lastly, they found that mandate insurance coverage generated a statistically significant increase in the BMI of diabetics and that the effect is of practical significance, which is a clear example of moral hazard's effect on diabetes.

Cohen and Dehejia (2004) examined the moral hazard effect of compulsory auto insurance laws on the driver's behavior and traffic fatalities using panel data from 50 states in the U.S. including the District of Columbia. They found evidence that compulsory insurance regulations do deliver their intended effect, i.e. a significant reduction of uninsured motorists, and that automobile insurance has significantly reduced precautions and increased traffic fatalities.

Decker (2005) investigated the phenomenon of the surge in health insurance coverage occurring for most uninsured American women when they turn 65. This paper focused on woman between 50 and 80 years old and their use of health services and breast cancer status.

First the research tested whether the Medicare program improves access to early detection service, and it also tested whether Medicare improved diagnosis or survival of breast cancer. An important finding was that turning 65 led to a big discrete jump in the use of health services, including mammography. In addition, women without a high school education increased their likelihood of having a recent mammogram by nearly five percentage points at age 65, compared to an one percentage point or smaller increase for college-educated women.

Dave and Kaestner (2006) examined the effect of health insurance on health behaviors by investigating the Medicare effect on health behaviors for the elderly using data from Health and Retirement Study (HRS). They researched a few primary health behaviors such as smoking, weight, exercise and heavy drinking. By applying Difference-in-Difference (DD) methodology and comparing persons before and after age 65, they have found significant evidence that obtaining health insurance not only reduces preventative behaviors, but also increases unhealthy behaviors among elderly men, i.e. an increase in probability of smoking and alcohol use and lower probability of physical exercise. Moreover, they also found empirical evidence that physician visits improve health behaviors.

Rashad and Markowitz (2007) examined the relationship between obesity and health insurance status by using data from the Behavioral Risk Factor Surveillance System from 1993 to 2002. They identified that people with health insurance may change their behaviors towards weight control as prevention. They used instrument variables and have shown evidence that having insurance is associated with higher body mass and an increased probability of being overweight. Preux (2010) examined the effect of Medicare and its effect on health-related behaviors of the uninsured by using Health and Retirement Study data. He found that there is a difference in smoking and physical exercise between insured and uninsured (i.e., smoking more but exercise less). The results suggested that insurance coverage may still have incentives to reduce investment on prevention care.

The literature above all shows that moral hazard effect of health insurance on healthy behaviors. Notwithstanding, some empirical study results do not provide evidence for a moral hazard effect.

Courbage and Coulon (2004) used the 2000 British Household Panel Survey data to test for of ex-ante moral hazard effect in UK system. Based on their univariate probit model which controlled for individual observed characteristics, they examined if purchasing private health insurance could change the probability of walking, swimming or doing sports, smoking, and breast screening. They used two behavioral variables - the frequency of exercising and being a smoker. Finally, they found that the insured tend to be non-smoker, showing evidence that private health insurance coverage reduced unhealthy behavior and suggesting an absence of ex-ante moral hazard effect. In addition, the results also showed that private health insurance increased the probability of preventative behavior. However, their paper has a big argument in applying univariate probit model. They ignored that purchasing insurance coverage is not independent of the lifestyle choice and this would cause biased results in estimating the effects of health insurance on lifestyle choices.

Card et al. (2004) used survey data from the NHIS and the Behavioral Risk Factor Surveillance System (BRFSS) to examine two different age profile (the 62-64 group vs. the 65 and above group) lifestyle behaviors such as smoking and exercise. The authors discussed the relationship between lifestyle behaviors and the use of preventive services by looking at smoking, exercise and obesity (weight) between the two age profiles'. They found no evidence that Medicare eligibility or obtaining insurance is associated with the change in lifestyle behaviors such as smoking and weight. Furthermore, they found no evidence that Medicare eligibility leads to increases in the demand for preventative screening such as blood cholesterol testing or mammography.

In sum, most empirical studies suggest that the moral hazard effect is present between the healthy related behavior and health insurance, but some studies suggest lack of evidence to explain the moral hazard effect is existence.

In addition, Stanciole (2007) and Balia and Jones (2008) have shown important determinants of health insurance effects on individual's lifestyle behaviors in applying multivariate probit model. They discussed the effects of health insurance on multi-healthy behaviors and stated that previous researches have not considered a formal framework incorporating unobservable heterogeneity under this circumstance and the results would make a biased estimator.

Stanciole (2007) examined the moral hazard effect of health insurance on "lifestyle choices", namely, heavy smoking, heavy drinking, and obesity by using the data from of the Panel Study of Income Dynamics. He applied univariate probit, bivariate probit, and multivariate probit models to estimate the effects. The bivariate probit model had a similar result to the multivariate probit model in capturing the effects of unobservable individual heterogeneity. According to the multivariate probit model, he found evidence of moral hazard in that having health insurance raises the incentive for smoking and obesity; however, health insurance appeared to have decreased the incentive for heavy drinking. Balia and Jones (2008) investigated the contribution of lifestyle choices (smoking, sleep and drinking) to mortality in Great Britain by using a multivariate probit model. They found that smokers and heavy drinkers report lower health status, and these harmful activities also increase the probability of death.

In my empirical study, I first follow Courbage and Coulon (2004) to apply the univariate probit model to measure the effects on two unhealthy lifestyles - smoking and alcohol consumption - independently. However, this could generate a inefficient result in estimating the effects of health insurance on lifestyle choices. According to Manrique and Jensen (2004) suggestion that decisions to purchase tobacco and alcohol beverages are related, and they suggested that these two behaviors should be modeled as a joint consumption decision. In order to capture the correlation between smoking and alcohol consumption, I take Manrique and Jensen (2004) suggestion and then follow Stanciole (2007) to apply the seemingly unrelated bivariate probit model in capturing the effects of unobservable heterogeneity in my empirical research.

3.2.3 Health related behavior and health insurance in Taiwan

Regarding the studies on medical service utilization under Taiwan's NHI, there have been very few studies focused on lifestyle related behavior. Hsieh et al. (1996) examined the effects of health knowledge on unhealthy smoking behavior by using a standard probit model. The data was from 1993 national survey from the Institute of Public Health, National Taiwan University. They found people with more health knowledge were less likely to be smokers. Males have a significantly higher smoking rate. Education level was also negatively correlated with smoking.

Chen et al. (2001) discussed some determinates and risk factors on lifestyle behavior such as smoking, alcohol consumption and illicit drug use by applying the logistic regression model. By using a survey of 6,318 participants aged 13 to 35 in I-Lan County, Taiwan, between 1996 and 1997. They found that for males, smoking and alcohol consumption were both positively and significantly correlated with age. As for education level, the less educated were significantly more likely to be smokers, but this finding did not apply to drinking. This paper only focused on the study of personal demographic characteristics, also the sampled population only consist of young people, furthermore, the study was only carried out in one county (out of 21 counties) in Taiwan.

Tseng and Lin (2008) examined health-related behaviors (such as cigarette smoking, betel nut chewing[2], alcohol drinking, preventative service utilization, and level of physical activity) among different gender and age groups using factor analysis. This study was based on a total of 26,755 participants from the 2002 National Survey on Knowledge, Attitude, and Practice of Health Promotion in Taiwan. Their finding showed that older people were more likely to practice protective behaviors such as using prevention services and being physically active. On the other hand, younger males were more likely to participate in risky behaviors such as cigarette smoking, alcohol drinking, and betel nut chewing. This suggested that males were more likely to engage in risky behaviors compared to females.

Lin et al. (2009) explored health promoting lifestyles (e.g., physical activity and nutrition) and related factors in pregnant women by sampling 172 pregnant women in southern Taiwan. Their results showed that pregnant women with higher socio-economic status coupled with good health status were more like to engage in more health promoting lifestyle behaviors. In addition, regular exercise was positively correlated with health promoting lifestyles for pregnant women. However, this study was limited by the small sample size.

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[2] Betel nut is a psychoactive drug of the Asian countries. People usually chew it for stress reduction and heightened awareness. Betel nut chewing is not only associated with increased risk of cardiovascular disease, but it also has found by World Health Organization that chewing betel nuts can cause oral cancer.

Besides the national health insurance plan's effect on the demand for cigarette or alcohol consumption, the price and taxes on cigarette and alcohol may also influence cigarette and alcohol consumption. Lee (2008) studied cigarette price elasticity to estimate the effects on cigarette consumption from an increased cigarette tax by using cross-sectional data in Taiwan. He applied the Tobit model in order to estimate cigarette's demand elasticity, and found that a 44% increase in the price of cigarettes would reduce the annual cigarette consumption by 14.86 packs per person. The results also suggested that a large increase in cigarette tax would effectively eliminate cigarette consumption, as well as increasing the government cigarette tax revenue. Lee et al. (2010) analyzed an imposed health tax on cigarettes that was aimed to reduce cigarette consumption as well as alcohol consumption in 2009 by estimating the own-price elasticity of cigarettes and alcohol. They applied a seemingly unrelated regression model using time series data and found that a health tax of 10 New Taiwan Dollar (USD. $0.3) per pack on cigarettes would reduce consumption by 13.19%. In addition, they found that alcohol was complementary goods with cigarettes. However, in my empirical research, I only focus on the relationship between lifestyle related behaviors and Taiwan's national health insurance, and do not examine any price or taxation effects on cigarette and alcohol consumption.

In sum, most of the aforementioned studies considered the effects of health insurance on either preventative activities or health related behaviors. In theory, there are reasons to believe that health insurance coverage may increase an individual's risky behaviors and/or reduce preventative activities. However, empirical studies have yet to provide sufficient evidence to support this prediction. In my third empirical model, I employed a Difference-in-Difference model in order to compare how these effects change before and after the implementation of

Taiwan's national health insurance system, and how the impact changed over time in response to the National Health Insurance reform in 1995.

Chapter 4. Theoretical model

In this chapter, I set out to modify and build a moral-hazard model of national health care insurance plan, with the patient's copayment rate, the premium, and the payroll tax rate incorporated in the model. I use an extension of the models proposed by Ehrlich and Becker (1972) and Stanciole (2007) and incorporate the "two-stage individual decision" model in my theoretical model. In stage one, an individual moves first and decides his/her optimal unhealthy behavior (β^*) before knowing the health status. In stage two, once the health status is revealed, he/she will move next to decide the optimal amount of medical care (m^*) given his/her optimal unhealthy behavior (β^*). The theoretical model serves as the foundation in analyzing Taiwan's national health care program. The following assumptions are pertinent to the model specification.

4.1 Model introduction and assumptions

In general insurance theory, the expected utility model is the standard criterion used to formally analyze individual behavior under uncertainty. I modify the models proposed by Ehrlich and Becker (1972) and Stanciole (2007) and consider a risk averse individual who spends his / her disposable income on only two types of goods: a homogenous health care service (medical treatment) (m), and other consumption goods (x). Let the price of medical treatment be set as a constant P_m and set P_x as the price for other consumptions (x). The individual's utility after falling sick is expressed as $U(x, m)$, which is a strictly increasing and concave function, i.e., $U'(x, m) > 0$, $U''(x, m) < 0$. Y is the individual's initial income before tax, for simplicity, I normalize $P_x = 1$. The probability of being sick $P(\beta)$ is a function of whether the individual engage in risky behaviors (i.e. smoking, drinking) or not ($\beta = (0,1)$). If the consumer has no unhealthy behavior, then $\beta = 0$. The unhealthy behavior (β) does provide a level of utility U (β)

for the individual through fulfilling the needs to satisfy their physical/ mental addiction for alcohol/ cigarette. I assume that *U* increases with unhealthy behaviors but at a decreasing rate, ie: $U'_{\beta} = \frac{\partial U}{\partial \beta} > 0$, and $U''_{\beta} < 0$.

In addition, I follow Bhattacharya and Sood's (2006) assumption that these behaviors give individual some level of disutility, i.e., deteriorating the individual's health. Therefore, I assume that the consumer disutility is associated with the form of utility loss (D) where $D[S(\beta), m]$, in which $D[S(\beta), m] \leq 0$. The utility loss (D) depends on the "sick" status (S) and amount of medical treatment consumed (m). In addition, I assume sick status (*S*) is a function of unhealthy behavior (β), meaning unhealthy behaviors influence S, as S increased as individual's sick status is becoming poorer. The S (sick status) variable increase with the unhealthy behavior (β)variable at an increasing rate, ie: $S'_{\beta} = \frac{\partial S}{\partial \beta} > 0$, meaning that addiction of unhealthy behavior will be detrimental to individual's sickness, and at an increasing rate, $S''_{\beta\beta} = \frac{\partial^2 S}{\partial \beta^2} > 0$.The medical service *m* here is medical treatment rather than preventative care. In addition, in case of sickness, individual has a maximum utility loss if he / she doesn't visit a doctor. Therefore, I assume $D[S(\beta), m]$ approaches to ∞ if m=0 and in case of health, $D[S(\beta), m] = 0$ if *S*=0.

I assume that the utility loss D should increase with medical treatment *m*, i.e., $D'_m = \frac{\partial D}{\partial m} > 0$, which means that if the individual receives more medical service, he / she will increase utility. I further assume that the marginal effect of medical treatment on the loss of utility is increasing at decreasing rate, i.e., $D''_{mm} = \frac{\partial^2 D}{\partial m^2} \leq 0$. In other words, the more medical service received by an individual, the smaller the effects of an additional unit of medical service on utility loss. Also, the utility loss D should decrease with S (sick status) at a decreasing rate, ie: $D'_S = \frac{\partial D}{\partial S} < 0$, which means the more severe the sickness, individual loses more utility and $D''_{SS} = \frac{\partial^2 D}{\partial S^2} < 0$, meaning the more severe sickness, the smaller the additional unit of sick status on utility loss. At the same time, I assume the marginal effect of medical service on the loss of utility increases with the level of sickness condition, i.e., $D''_{ms} = \frac{\partial^2 D}{\partial \mathrm{m}\, \partial \mathrm{s}} > 0$, meaning the sicker the individual, the larger the extra-unit of medical service the individual will consume.

Moreover, I assume that unhealthy behavior (β) increases the probability of being sick. The probability function is increasing at an increasing rate, i.e., $P'(\beta) > 0$, $P''(\beta) \geq 0$ .The probability of being healthy is $1 - P\ (\beta)$.

In the case of sickness, the individual encounters a loss in income $L\ (m, \beta)$ which depends on the amount of medical services consumed m and on whether the individual engaged in unhealthy behavior β. In other words, L is a function of medical service and smoking or drinking expenses, respectively. Assuming L is a strictly increasing convex function for both m and β: $L'_m = \frac{\partial L(.)}{\partial m} > 0$, meaning that patient who uses more medical services will pay more money; and $L'_\beta = \frac{\partial L(.)}{\partial \beta} > 0$, meaning individual who engages in more unhealthy behavior will also spend more. I further assume that the marginal effect of medical spending is increasing with medical services because L is a strictly increasing convex function, i.e., $L''_{mm} = \frac{\partial^2 L(.)}{\partial m^2} \geq 0$, meaning the more medical services received by patients, the higher their marginal medical costs. The marginal effect of unhealthy behavior spending is also increasing with itself, i.e., $L''_{\beta\beta} = \frac{\partial^2 L(.)}{\partial \beta^2} \geq 0$, meaning the more unhealthy behavior the individual consumes, the higher his / her marginal costs. In addition, I assume that the marginal effect of medical spending is increasing with unhealthy behaviors, i.e., $L''_{m\beta} = \frac{\partial^2 L(.)}{\partial m \partial \beta} > 0$, meaning the more unhealthy behavior patients have, the higher their marginal medical cost.

On the other hand, in the case of health, the individual encounters only a loss in income $L\ (\beta)$ which depends on whether the individual engages in unhealthy behavior β. The individual has to pay a premium R and payroll tax $Y \times t$ (t is payroll tax rate). Moreover, in the case of treatment, he/she has to pay a fixed share *c* of the expenditures for medical treatment (copayment rate: $0 < c < 1$).

Finally, since in my model, medical service m only refers to medical treatment and not preventative care, therefore it only affects the income loss $L\ (m, \beta)$ and disutility $D[S(\beta), m]$. Again, the utility loss could be measured by $D[S(\beta), m]$, in which $D[S(\beta), m] \leq 0$ and $D[S(\beta), m] \rightarrow \infty$ when *m*=0 if the individual is sick, and $D[S(\beta), m] = 0$ (S=0, no disutility loss) if the individual is healthy.

4.2 Individual's utility function and budget constraint

The government of Taiwan launched a public health insurance program in 1995. The funding for the public insurance program comes from individuals, employers and the government. The contribution is proportional to individual income as determined by the payroll tax $Y \times t$, where *t* is the payroll tax rate and *Y* is individual income before tax. Also, under the universal health insurance program, the individual pays a copayment rate *c* when he / she visits a doctor, where $0 < c < 1$. The individual also pays a premium R every month and pays a total copayment of $c * p_m * m$ to visit a doctor. In other words, the government will pay $(1 - c) * p_m * m$ for the patient; here I assume that the government sets the same price of premium R for everyone. Now, with Taiwan's National Health Insurance (NHI) system, the new budget constraint for the patient is:

$$x + tY + c * p_m * m + \mathrm{R} + L(m, \beta) = \mathrm{Y} \quad (1)$$

If the individual becomes sick, his/her utility function would be:

$$\mathrm{U}(x, m)^{\mathrm{sick}} = \mathrm{U}\,(x) + D[S(\beta), m]$$

$$= \mathrm{U}\left(\mathrm{Y} - tY - c * p_m * m - \mathrm{R} - L(m, \beta)\right) + D[S(\beta), m\,] \quad (2)$$

As for the healthy individual, his/her utility function is:

$$U(x, m)^{health} = U[Y - tY - R - L(m, \beta)\,] \qquad \text{where } m\text{=0} \quad (3)$$

Here, I assume the expected utility of β, $U[\beta]$, is incorporated in individual's utility function and also assume that the expected utility for a sick person can be expressed as an additively-separable function.[3] In addition, healthy people still need to pay the payroll tax from wages and premium as well. Furthermore, I assume that a patient already established his/her lifestyle behaviors β before becoming sick. In my paper, I assume that there is no inter-temporal transfer of income (i.e., either lender or borrower) and lastly, public health insurance is the sole option (without considering the existence of very small private health insurance in Taiwan).

The expected utility for an individual can then be expressed as:

$$EU = P\,(\beta)\{U[(Y - tY - cp_m m - R - L(m, \beta)] + D[S\,(\beta), m]\}$$

$$+ \left(1 - P\,(\beta)\right)U[Y - tY - R - L(\beta)\,] + U[\beta]$$

$$= P\,(\beta)\mathrm{U}_1 + \left(1 - P\,(\beta)\right)\mathrm{U}_2 + U[\beta] \quad (4)$$

[3] Blomquist (1997) ,Schnider (2005), and Bhattacharya and Sood (2006) assume the utility function is additively separable.

where

$U^{sick} = U_1 = U[(Y - tY - cp_m m - R - L(m, \beta)] + D[S\,(\beta), m]$,

$U^{Health} = U_2 = U\big(Y - tY - R - L(\beta)\big)$, and

$U[\beta]$ incorporates in U^{sick} and U^{Health}. with $U_1 < U_2$

The Third-party payer

A third-party payer refers to the government which finances the health care program with the premium R and a payroll tax from individual, but is not directly involved in the treatment decision. In my model, all individuals are identical in their utility (including the probability of getting sick) by assuming the existence of the "representative individual". The budget of Taiwan's national health insurance system is balanced as shown in the following equation:

$$R + tY = P\,(\beta)(1 - c)p_m \int [m^*(\beta)] f(\beta) d\beta \qquad (5)$$

Equation (5) shows the balanced government budget with national health insurance spending. The left hand side is the government receipts from premiums and payroll tax collection. The right hand side is the government's total copayment expenses for individuals (through their doctor visits given unhealthy behavior).

4.3 Optimal unhealthy behavior choice and optimal medical care

I apply the Stackelberg two-stage individual decision model to analyze "behavior moral hazard". In the first stage, the individual moves first and decides his / her optimal unhealthy behavior before knowing health status. In stage two, once the health status is revealed, he / she will move to choose the optimal amount of medical care after knowing their optimal unhealthy behavior. In addition, I will discuss how changes in government policy parameters would affect individual's welfare through his / her health-related behavior under the universal health insurance system.

4.3.1 Selection of optimal medical service given optimal unhealthy behavior

In this model, I use a backward induction method from stage 2 to solve for as individual's optimal medical service (m*) given his / her optimal unhealthy behaviors β^*. In stage 2, an individual selects the optimal quantity of medical services given his / her realized state of health along with information on unhealthy behaviors. The objective function of the individual's utility maximization problem is the same as equation (4) given as follows:

$$Max \quad EU = P(\beta^*)\{U[(Y - tY - cp_m m - R - L(m, \beta^*)] + D[S\ (\beta^*), m]\}$$
$$+ \left(1 - P(\beta^*)\right)U[Y - tY - R - L(\beta^*)\ ] + U(\beta^*)$$

subject to $\quad x + cp_m m\ +\ R + tY +\ L(m, \beta^*) = Y$

Taking first derivative with respect to *m* (medical service):

F.O.C

$$\frac{\partial \text{EU}}{\partial m} = P(\beta^*)[(-cp_m - L'_m)U'(.) +\ D'_m(.)] = 0 \qquad (6)$$

There is an interior solution of optimal medical service for patient:

$$(cp_m + L'_m)U'(.) = D'_m(.) \qquad (7)$$

In equation (7), the left hand side is the marginal utility from copayment and spending by patient, and the right hand side is the marginal disutility of patient's sickness (increase of patient's health) given optimal unhealthy behavior β^*. In other words, the intuition of the F.O.C is that for a patient, the optimal medical service is reached once the marginal benefit from medical services equal to the marginal cost of medical services.[4]

In addition, I check the second order condition of the patient's utility function with respect to medical service to make sure that Eq. (6) is sufficient for this optimization problem, i.e.:

$$\frac{\partial^2 EU}{\partial m^2} = P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_{mm}(.)U''(.) - L''_{mm}(.)U'(.)] + D''_{mm}(.)\} < 0 \quad (8)$$

With the assumptions that $U''(.) < 0$, $L''_{mm}(.) \geq 0$ and $D''_{mm}(.) \leq 0$. The second order condition of the optimization problem satisfies the patient's expected utility maximization.

4.3.2 The effect of the exogenous variables on the individual's decision of optimal medical service *m** given β^*

From the F.O.C in equation (6), I can obtain the individual's optimal level of medical consumption $m^*(Y, t, c, S, p_m, R, \beta^*)$ given β^*, I also discuss how each of the seven exogenous variables affects the optimal medical service consumption.

With $D''_{mm} = \frac{\partial^2 D(.)}{\partial m^2} \leq 0$, $D''_{ms} = \frac{\partial^2 D(.)}{\partial m \partial s} > 0$ as previously assumed, I can then determine the signs of $\frac{dm^*}{dY}$, $\frac{dm^*}{d(1-t)}$, $\frac{dm^*}{dc}$, $\frac{dm^*}{dS}$, $\frac{dm^*}{dp_m}$, $\frac{dm^*}{dR}$ and $\frac{dm^*}{d\beta^*}$. Which in turn give the following results[5]:

Result 1:

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[4] If a corner solution exists, ie: $m^*=0$, the condition of $\frac{\partial EU}{\partial m} \leq 0$ should hold, and that the marginal utility of other goods consumed due to the reduction in medical service is always greater than the marginal health loss from the reduction in medical service.

[5] See the Appendix 1 for details.

$$\frac{dm^*}{dY} = \frac{P(\beta^*)[(1-\mathrm{t})(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} > 0$$

If an individual's income increases, medical service consumption (*m*) will increase as well given β*. In other words, people with higher income will demand more medical service, and vice versa. Manning and Marquis (1996) also found a positive income elasticity of demand for medical services.

Result 2:

$$\frac{dm^*}{d(1-t)} = \frac{P(\beta^*)[Y(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} > 0$$

If the government sets a low payroll tax rate, then medical service consumption will increase given β*. Because of the low payroll tax that an individual pays, he / she now has more disposable income, thus allowing he / her to consume more medical service. Feldstein (1977) also described that tax subsidy encourages patients to purchase extra health insurance coverage.

Result 3:

$$\frac{dm^*}{dc} = \frac{P(\beta^*)[p_m * U'(.) - mp_m(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} < 0$$

If the government sets a high copayment rate for an individual to visit the doctor, then medical service consumption will decrease given β*.

Result 4:

$$\frac{dm^*}{dS} = -\frac{P(\beta^*)[\,D''_{ms}(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} > 0$$

If the individual has a severe illness, like cancer or other deadly diseases, the patient would need more medical service to recover given β*. Healthier patients will demand less medical service.

Result 5:

$$\frac{dm^*}{dp_m} = \frac{P(\beta^*)[c * U'(.) - mc(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} < 0$$

If the price of medical service increases, the individual cannot afford more medical service, and the individual's demand for medical use will decrease given β^*. On the other hand, if the price of medical service is relatively low (i.e. $p_m \rightarrow 0$) then the patient will demand more medical services, all things equal. This is also consistent with (Cutler and Zeckhauser's, 2000, p. 584) finding of a price elasticity of demand for medical services of – 0.2.

Result 6:

$$\frac{dm^*}{d\mathrm{R}} = -\frac{P(\beta^*)[(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} < 0$$

If the government sets a high premium for the individual to pay, then the individual's demand for medical service consumption will decrease given β^*. The individual would have less disposable income to spend on other medical costs (including copayments and medical services not covered).

Result 7:

$$\frac{dm^*}{d\beta^*}$$

$$= \frac{P(\beta^*)\{L''_{m\beta}\,[\mathrm{U}''(.) - \mathrm{U}'(.)] + L'_{\beta} cp_m \mathrm{U}''(.) - D''_{mS}\,(.)S'_{\beta}]\} - P'(\beta^*)[(cp_m + L'_m)U'(.) + D'_m(.)]\,\}}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}}$$

$$> 0$$

If the patient engages in more unhealthy behaviors, like smoking or drinking alcohol, he / she will be expected to demand more medical service.

With the above results, I now describe the patient's optimal medical service consumption as $m^*(\mathrm{Y}, \mathrm{t}, \mathrm{c}, \mathrm{S}, p_m, \mathrm{R}, \beta^*)$.

4.3.3 Optimal unhealthy behaviors (β*)

In the previous section, I analyzed the optimal medical service m^* for individual given β^* in stage 2. Now, I will derive the optimal choice for unhealthy behavior β^* in stage 1 given the individual's optimal medical service consumption $m^*(Y, t, c, S, p_m, R, \beta^*)$. In stage 1, individual moves first to choose his / her optimal behavior, the expected utility function of his / her utility maximization problem with respect to the unhealthy behavior parameter β is the same as equation (4) given as follows, and the optimal level of β is:

$$\underset{\beta}{Max} \quad EU(\beta) = P(\beta)\{U[(Y - tY - cp_m m - R - L(m,\beta)] + D[S\,(\beta), m]\} +$$

$$(1 - P(\beta))U[Y - tY - R - L(\beta)\,] + U(\beta)$$

$$= P\,(\beta)U_1 + [1 - P\,(\beta)]U_2 + U(\beta) \qquad (4)$$

subject to $\quad x + cp_m m \, + \, R + tY + \, L(m,\beta) = Y$

where

$U^{sick} = U_1 = U[(Y - tY - cp_m m - R - L(m,\beta)] + D[S\,(\beta), m]$,

$U^{Health} = U_2 = U\big(Y - tY - R - L(\beta)\big)$, and

$U(\beta)$ incorporates in U^{sick} and U^{Health} . with $U_1 < U_2$

Taking first derivative with respect to β (lifestyle behavior choice):

$U'(\beta) =$

$$P'(\beta)[U_2(.) - U_1(.)] + P(\beta)\big[L'_\beta U'_1(.)\big] + [1 - \, P(\beta)]\big(L'_\beta\,\big)U'_2(.) - P(\beta)[D'_S\,S'_\beta]U'_1(.) \qquad (9)$$

Equation (9) above describes an individual's optimal unhealthy behavior (β*) under universal health insurance plan. The marginal benefit (left- hand side of the equation) is the individual's marginal utility received from engaging in risky behavior, and is set to equal to marginal cost (right- hand side). The first term in the right hand side is the increasing marginal probability associated with utility loss from sickness, the second and third terms represent the marginal utility from sickness and healthy status associated with the costs of risky behaviors. The last term is the marginal utility (decreasing) of health status due to risky behavior.

Next, I check the second order condition of the patient's utility function with respect to unhealthy behavior to ensure that equation (9) is sufficient for this optimization problem[6],

$$\frac{\partial^2 EU}{\partial \beta^2} = P''(\beta)[U_1 - U_2\,] + 2P'(\beta)U'_1\{[-L'_\beta - D'_S\, S'_\beta]\} + P(\beta)\{[L''_{\beta\beta}\,(U''_1 - U'_1)] +$$
$$U''_1\,(D'_S\, S'_\beta)(D'_S\, S'_\beta - L'_\beta) + [(D''_{SS}\, S'_\beta) + D'_S S''_{\beta\beta}]U'_1\} +$$
$$[1 - P(\beta)][(-L''_{\beta\beta})U'_2 + L''_{\beta\beta}U''_2] + U''(\beta) < 0 \tag{10}$$

With the assumptions that $U''(.) < 0$, $L''_{\beta\beta}(.) \geq 0$, $D'_S < 0$,and $D''_{SS}(.) \leq 0$ and $S''_{\beta\beta}(.) \geq 0$, the second order condition of the optimization problem satisfies the patient's expected utility maximization.

4.3.4 The effect of the exogenous variables on the optimal unhealthy behavior β^*

From the F.O.C of equation (9), I now obtain the individual's optimal level of unhealthy behavior β^* (Y, t, c, S, p_m ,R, m). I will also discuss the effects of seven exogenous variables on the optimal unhealthy behavior. For simplicity, let $X = \frac{\partial^2 EU}{\partial \beta^2}$ as equation (10) above.

[6] Please see appendix 2 for more details

I find the following results[7]:

Result 8

$$\frac{d\beta}{dY} = -\frac{P'(\beta)[(1-t)U'_1] - P(\beta)(1-t)L'_\beta U''_1 + P'(\beta)[(1-t)U'_2] + P(\beta)\left(D'_S S'_\beta\right)(1-t)U''_1 - [1-P(\beta)](1-t)L'_\beta U''_2}{X} > 0$$

A higher disposal income leads to an increase in consumption of unhealthy behaviors (implying individuals view lifestyle behaviors as normal goods).

Result 9

$$\frac{d\beta}{d(1-t)} = -\frac{\{P'(\beta)[YU'_1] - P(\beta)YL'_\beta U''_1 + P'(\beta)[YU'_2] + P(\beta)\left(D'_S S'_\beta\right)(Y)U''_1 - [1-P(\beta)]YL'_\beta U''_2\}}{X} > 0$$

(i.e., $\frac{d\beta}{dt} < 0$)

A higher payroll tax rate leads to a decrease in individual's unhealthy behaviors.

Result 10

$$\frac{d\beta}{dp_m} = -\frac{P'(\beta)[(-cm)U'_1] + P(\beta)\left(D'_S S'_\beta\right)(-cm)U''_1 - P(\beta)(-cm)L'_\beta U''_1}{X} < 0$$

A higher price for medical service will leads to a decrease in individual's unhealthy behaviors.

Result 11

$$\frac{d\beta}{dc} = -\frac{P'(\beta)[(-p_m m)U'_1] + P(\beta)\left(D'_S S'_\beta\right)(-p_m m)U''_1 - P(\beta)(-p_m m)L'_\beta U''_1}{X} < 0$$

[7] Please see appendix 3 for more details.

A higher copayment rate will leads to a decrease in individual's unhealthy behaviors.

Result 12

$$\frac{d\beta}{dR} = -\frac{P'(\beta)[(-1)U'_1] - P(\beta)(-1)L'_\beta U''_1 + P'(\beta)[U'_2] + P(\beta)\left(D'_S S'_\beta\right)(-1)U''_1 + [1 - P(\beta)]L'_\beta U''_2}{X} < 0$$

A higher premium has a negative effect on individual's unhealthy behaviors.

Result 13

$$\frac{d\beta}{dS} = \frac{P'(\beta)[(D'_S)U'_1] - P(\beta)L'_\beta[U''_1 (D'_S)] + P(\beta)(D''_{SS}) + P(\beta)\left(D'_S S'_\beta\right)(D'_S)U''_1}{X} < 0$$

Individuals with a poor health status (i.e, as S increases) will decrease their unhealthy behaviors.

Result 14

$$\frac{d\beta}{dm} = -\frac{P'(\beta)[U'_1(-cp_m - L'_m) + D'_m U'_1] + P(\beta)U''_1 [(cp_m + L'_m) + D'_m]\left[\left(D'_S S'_\beta\right) - L'_\beta\right]}{X} < or > 0$$

Medical services utilization has an ambiguous effect on unhealthy behaviors. This is due to the two opposing effects at play: a positive effect of medical treatment and a negative effect of individual's medical spending and disutility through sick statues. If a positive effect's magnitude is relatively greater than the negative effect, then, medical service utilization's total effect on unhealthy behavior would be positive.

To sum up, the individual's unhealthy behaviors decrease with the following changes in the public health insurance program: higher copayment rate, higher payroll tax rate, higher medical price, poor health status, and higher premium. On the other hand, unhealthy behaviors increase with income level. Medical service has an ambiguous effect. With the results above, I can now express the individual's optimal level of unhealthy behavior as β^* (Y, t, c, S, p_m , R, m). This utility function could also be expressed indirectly as $V^{individual}(Y, t, c, S, p_m, R, m)$. Therefore, the unhealthy behaviors' expected utility function for the individual could be written as:

$$EU^{induvudual}(\beta) = \int \{P\,(\beta)\mathrm{U}_1 + [1 - P\,(\beta)]\mathrm{U}_2 + U(\beta)\}\, f(\beta)d(\beta)$$

$$= \int \{P(\beta)\{U[(Y - tY - cp_m m - R - L(m, \beta)] + D[S\,(\beta), m]\}$$

$$+ \big(1 - P(\beta)\big)U[Y - tY - R - L(\beta)\,] + U(\beta)\}\, f(\beta)d(\beta)$$

$$= \int V^{individual}(Y, t, c, S, p_m, R, m) f(\beta)d\beta$$

4.4 The objective of the government

Due to the fact that Taiwan's health care system is public and open to all people, the government is assumed to be the social planner. The government sets the premium *R*, the copayment rate *c,* and the payroll tax rate *t* of the national health insurance. In addition, I also assume homogeneity among individuals.

4.4.1 Individual's well-being social welfare

The objective of the government is to choose the copayment rate *c,* the payroll tax rate *t* and premium *R* in order to maximize the individuals' well-being (expected utility).[8]

$$\underset{(c,R.t)}{Max} \quad EU^{induvudual} = \int\{P\ (\beta)U_1 + [1 - P\ (\beta)]U_2 + U(\beta)\}\, f(\beta)d(\beta)$$

Stewart (1994) assumed that an insurance company maximizes patient's expected utility with respect to the copayment parameter. Here in my model, the insurer is Taiwanese government, and it considers this objective function subject to four difference constraints:

1. The patient's individual budget constraint as in equation (1):

$$x + tY + c * p_m * m + R + L(m, \beta) = Y$$

2. The government's budget constraint in equation (5):

$$R + tY = P\ (\beta)(1 - c)p_m \int[m^*(\beta)]f(\beta)d\beta$$

3. The constraint given by individual's medical service optimization (F.O.C of equation (7))

$$(cp_m + L'_m)U'(.) = D'_m$$

4. The constraint due to individual's optimal unhealthy behavior in equation (9):

$$U'(\beta) = P'(\beta)[U_2(.) - U_1(.)] + P(\beta)\left[L'_\beta U'_1(.)\right] + [1 - P(\beta)]\left(L'_\beta\right)U'_2(.)$$
$$- P(\beta)[D'_S\, S'_\beta]U'_1(.)$$

Where $U_1 = U[Y - tY - cmp_m - R - L(m, \beta)] + D[S(\beta), m)$

$$U_2 = U(Y - tY - R - L(\beta))$$

Therefore, the objective function of the government (insurer) to maximize individuals' well-being is:

[8] This approach follows by Bardey and Lesur (2006).

$$\underset{(c,t,R)}{Max} \quad EU^{indivudual} = \int\{P(\beta)\{U[(Y - tY - cp_m m - R - L(m,\beta)] + D[S\,(\beta), m]\} + (1 - P(\beta))U[Y - tY - R - L(\beta)\,] + U(\beta)\}f(\beta)d(\beta) \qquad (11)$$

Subject to $x + tY + c * q * m + R + L(m, \beta) = Y$

$$R + tY = P\,(\beta)(1 - c)p_m \int[m^*(\beta)]f(\beta)d\beta \;,$$

$(cp_m + L'_m)U'(.) = D'_m$, and

$$U'(\beta) = P'(\beta)[U_2(.) - U_1(.)] + P(\beta)\big[L'_\beta U'_1(.)\big] + [1 - \; P(\beta)]\big(L'_\beta\,\big)U'_2(.) - P(\beta)[D'_S\,S'_\beta]\;U'_1(.)$$

4.4.2 The effect of policy parameters on individual's well-being

After substituting the government's budget constraint, the new well-being expected utility function can be written as:

$$\underset{(c,t,R)}{Max} \quad EU^{indivudual} = \int\{P(\beta)\{U[(Y - P\,(\beta)(1 - c)p_m m - cp_m m - L(m,\beta)] + D[S\,(\beta), m]\} + (1 - P(\beta))U[Y - P\,(\beta)(1 - c)p_m m - L(\beta)\,] + U(\beta)\}f(\beta)d(\beta)$$

Where $U_1 = U[Y - tY - cmp_m - R - L(m, \beta)] + D[S(\beta), m]$

$$U_2 = \; U(Y - tY - R - L(\beta))$$

With $\frac{\partial m}{\partial c} < 0, and\ \frac{\partial \beta}{\partial c} < 0$, the F.O.C with respect to changes in copayment rate *c* can be derived as[9]

[9] See Appendix 4 for details.

$$\frac{\partial \text{EU}}{\partial c} = \int\{-P(\beta)p_m m U_1' + P(\beta)p_m m[P(\beta)U_1' + (1-P(\beta))U_2'] - P(\beta)(1-c)p_m m_c[P(\beta)U_1' + (1-P(\beta))U_2'] - P'(\beta)(1-c)\,\beta_c p_m m[P(\beta)U_1' + (1-P(\beta))U_2']\}\,f(\beta)d(\beta) \quad (12)$$

In equation (12) above, the first term is the marginal effect of decreasing medical spending for patients, the second term is marginal indirect effect of medical spending on individuals, the third term is the indirect effect from individual's the premium and payroll tax reduction from government, and the last term is the indirect effect of the marginal probability of unhealthy behavior from the premium and the payroll tax reduction.

If government increases individual's copayment rate, it would affect the well-being function in two aspects: If the decreasing in medical spending for patients is at a rate greater than the combined negative effects from decreasing the premium (R), payroll tax rate (*t*) reduction and medical spending through decreasing unhealthy behavior, individual's welfare will decrease, i.e., $\frac{\partial EU}{\partial c} < 0$. On the other hand, if the first term is smaller than the last three terms, an increase in the copayment rate will increase the individual's welfare, $i.e., \frac{\partial EU}{\partial c} > 0$

The F.O.C of changes in the payroll tax rate (*t*) and the premium (R) can be analyzed in the same manner.

$$\frac{\partial \text{EU}}{\partial t} = \int\{-P(\beta)(1-c)p_m m_t[P(\beta)U_1' + (1-P(\beta))U_2'] - P'(\beta)\,\beta_t(1-c)p_m m[P(\beta)U_1' + (1-P(\beta))U_2']\}\,f(\beta)d(\beta) > 0 \quad (13)$$

With $m_t < 0$ and $\beta_t < 0$, the payroll tax rate has a positive effect on the individual's welfare ($\frac{\partial EU}{\partial t} > 0$). The first term is the direct effect from decreasing medical spending and indirect effect from government payroll tax reduction on medical services due to a decrease in the individual's medical service utilization. The second term is the direct effect from decreasing medical spending and indirect effect of from a premium due to the individual's decrease in unhealthy behavior. The health care bill has two positive effects on an individual who pays the bill. The first positive effect is from decreasing individual's medical spending because higher payroll tax rate causes less medical service consumption as well as less unhealthy behavior. The second positive effect is from the indirect effect of government payroll tax and premium reduction, because a higher payroll rate causes medical service consumption as well as unhealthy behavior to decrease. This implies that when the government imposes a payroll tax, an individual will expect to pay more for healthcare cost. However, an individual also could gain more social welfare not only from the positive direct effect of decreasing medical spending, but also from the positive indirect effect from government payroll tax reduction due to the decrease in unhealthy behavior.

$$\frac{\partial \mathrm{EU}}{\partial R} = \int \{-P(\beta)(1-c)p_m m_R[P(\beta)U_1' + (1-P(\beta))U_2'] - P'(\beta)\,\beta_R(1-c)p_m m[P(\beta)U_1' + (1-P(\beta))U_2']\}\, f(\beta)d(\beta) > 0 \tag{14}$$

With $m_R < 0$ and $\beta_R < 0$, premium also has a positive effect on the individual's welfare ($\frac{\partial EU}{\partial R} > 0$). The first term is the direct effect from decreasing medical spending and indirect effect from government premium reduction on medical services due to a decrease in the individual's medical service utilization. The second term is the direct effect from decreasing medical spending and indirect effect of from a premium reduction due to a decrease in the individual's unhealthy behavior. When an individual pays the health care bill, there are two positive effects from the premium increase. The first positive effect come from the decrease in individual's medical spending because higher premium causes a decrease in both medical service consumption and unhealthy behavior. The second positive effect is from the indirect effect of government payroll tax and premium reduction because higher premium can cause a decrease in both medical service consumption and unhealthy behavior. This implies that when the government imposes a higher premium, an individual will expect to pay more for healthcare cost. However, an individual also could gain more social welfare not only from the positive direct effect of decreasing medical spending, but also from the positive indirect effect from government premium reduction due to a decrease in unhealthy behavior.

4.5 Chapter conclusion

This theoretical model contributes to the literature in the following ways. Most of the previous studies in Taiwan regarding the determinants of lifestyle behaviors and medical service have been descriptive models, while most of the theoretical studies in other countries focused only on the effects on medical service utilization under private health insurance market. I modified and built a "behavioral moral hazard" theoretical model proposed by Ehrlich and Becker (1972) and Stanciole (2007) and applied to Taiwan's national health insurance setting. I attempted to derive and explain the determinants of demand for medical service and lifestyle behavior under a universal health insurance system. Moreover, I also examined how three government policy parameters – patient's copayment rate, premium, and payroll tax rate – affect individual's well-being given his / her lifestyle under Taiwan's NHI.

I used a two-stage individual decision model in my theoretical moral hazard model. In stage one, individual moves first and decides his / her optimal unhealthy behavior (β^*) before knowing his / her health status. In stage two, once the health status is revealed, he / she moves to decide the optimal amount of medical care (m^*) given optimal unhealthy behavior (β^*). By using backward induction, I found that after an individuals' falling sick in stage two, his / her optimal demand of medical service decreases with a higher payroll tax rate, a higher copayment rate, a higher premium, and a higher medical service price. However, the optimal demand of medical service increases with individual's income level, poor health status, and addiction to unhealthy behavior. In stage one, an individual's optimal unhealthy behaviors decrease with a higher copayment rate, a higher payroll tax rate, a higher premium, a higher medical price and poor health status. Lastly, individual's optimal unhealthy behaviors increase with income level, while medical service had an ambiguous effect.

In order to discuss the effects of three government policy parameters- copayment rate, premium, and payroll tax rate, I assume that there is a social planner whose objective is to maximize the representative's well-being (or social welfare). With the society consisting of homogenous individuals and the social planner is the Taiwanese government. My model results suggest that the copayment rate changes the individual's well-being under certain circumstances. If the decreasing in medical spending for patients is at a rate greater than the combined negative effects from decreasing the premium (R), payroll tax rate (t) reduction and medical spending through decreasing unhealthy behavior, individual's welfare will decrease, i.e., $\frac{\partial EU}{\partial c} < 0$. On the other hand, if the first term is smaller than the last three terms, an increase in the copayment rate will increase the individual's welfare, $i.e., \frac{\partial EU}{\partial c} > 0$

Lastly, following the same analogy, payroll tax rate has a positive effect on the individual's well-being. This implies that when the government imposes a payroll tax, an individual will expect to pay more for healthcare cost. However, an individual also could gain more social welfare not only from the positive direct effect of decreasing medical spending, but also from the positive indirect effect from government payroll tax reduction due to the decrease in unhealthy behavior. In addition, premium also has a positive effect on the individual's well-being. This implies that when the government imposes a higher premium, an individual will expect to pay more for healthcare cost. However, an individual also could gain more social welfare not only from the positive direct effect of decreasing medical spending, but also from the positive indirect effect from government premium reduction due to a decrease in unhealthy behavior.

Chapter 5 Econometric Model

The primary purpose of this empirical analysis is to analyze and test the hypotheses from the theoretical results from the previous chapter. First, I introduce the standard probit model to measure the effects on two unhealthy lifestyles - smoking and alcohol consumption - independently. Since this approach fails to capture the unobservable elements of smoking and alcohol consumption, I introduce the seemingly unrelated brivariate probit model in order to capture the effects on unhealthy lifestyles jointly because these two variable decisions are likely to be correlated contemporaneously. Finally, I use the difference-in-difference estimation to analyze changes before and after the implementation of Taiwan's national health insurance system in order to examine the existence of moral hazard effect.

5.1 Data

In my study, I select the dataset from the Survey of Health and Living Status of the Middle-Aged and Elderly (SHLS) in Taiwan[10]. The SHLS project was designed to (1) provide information on current status and longitudinal trends of social, economic, and health status, (2) investigate factors associated with the social, economic, and health issues, and (3) to understand current needs and project future demand in order to explore future Taiwanese government policy. The survey questions are designed to obtain important lifestyle behaviors (e.g. smoking and alcohol consumption), health information, demographic, socioeconomics and medical care utilization details directly from the interviewees. Medical care utilization includes outpatient, inpatient and pharmacy visit. Other information on family structure, economic condition, mental status, social participation and leisure time activities were also collected.

[10] The SHLS data is released by the Bureau of Health Promotion, Department of Health in Taiwan. Further information of SHLS can be found on the website at http://www.bhp.doh.gov.tw/bhpnet/English/ClassShow.aspx?No=200803270009

I choose this dataset as my empirical data source because most information needed in my empirical model could be provided by this dataset. The survey of the dataset has been regularly carried out since 1989 with a sample of 4,049 persons aged 60 years or over. The survey was designed to be a longitudinal structure and the sample was drawn randomly from the household registration system of Taiwan. The register includes all regular households, as well as residents of nursing homes and long-term care facilities. It was first performed by Taiwan provincial institution of family planning, Population Studies Centre of the University of Michigan and Department of Demography of Georgetown University. The survey after 2003 was carried out by the Bureau of Health Promotion and Department of Health in Taiwan.

The survey was conducted face-to-face in 6 waves: 1989, 1993, 1996, 1999, 2003 and 2007. The key variables in my study such as health related behaviors and other health information variables are contained in this dataset. In addition, this survey data provide individual's measurements of health, health care utilization, demographic and socioeconomic characteristics before and after the implementation of Nation Health Insurance (NHI) in 1995, which offers a natural experiment for evaluating the impact of NHI under a variety of circumstances.

Table 5.1 Survey of Health and Living Status of the Middle-Aged and Elderly (SHLS)

Wave	year	respondents	(age)	death of respondents (Cumulated)	no response	respond ratio
1	1989	4049	(60+)	-	363	91.8%
2	1993	3155	(64+)	582	312	91.0%
3	1996	2666	(67+)	1047	333	88.9%
	(add new samples)	2462	(50-66)	9	579	81.2%
4	1999	2310	(70+)	1486	253	90.1%
		2130	(53-69)	110	222	90.6%

5	2003	1743	(74+)	2133	173	91.0%
		2035	(57-73)	253	174	92.1%
	(add new samples)	1599	(50-56)	4	423	79.1%
6	2007	1268	(78+)	2661	120	91.4%
		1864	(61-77)	410	188	90.8%
		1402	(54-60)	38	159	89.8%

Source: Bureau of Health Promotion, Department of Health, Taiwan

In my paper, I use 2 panels from the second and sixth waves, conducted in 1993 and 2007, respectively. In 1993's panel, 3155 out of 4049 original respondents in the first wave were used because 582 of the initial respondents had died between 1989 and 1993. Among the survivors, the response rate in this panel was 91 percent (Table 5.1). In 1996's panel (the third wave), 2462 additional respondents in the 50-66 age group were added. 2003's panel (the fifth wave) includes the surviving respondents from the previous two waves (1743 from the first wave and 2035 from the third wave) along with 1599 additional respondents in the 50-56 age group. 2007's panel includes the surviving respondents from the previous three waves (1268 from the first wave, 1864 from the third wave and 1402 from the fifth wave). Panels from 1993 and 2007 were selected in my analysis in order to examine the effects of National Health Insurance on lifestyle behaviors, and to analyze the moral hazard effect of NHI plan to see if individuals' behaviors change after the implementation of NHI. The dataset from 1993 serves as control group since it was the year before Taiwan's NHI was initiated. Conversely, the 2007 data serves as the treatment group.

5.2 Estimation methodology and variables specification

In this section, I outline my estimation methodology. Lifestyle behaviors smoking and alcohol consumption are the dependent variables in my econometric model. The independent variables include health status, health care utilization, demographic variables, socioeconomic variables and other control variables. Health status variables are self-reported as good, fair, and bad health condition. The demographic variables in the model are age (in years), gender, and marital status. Socioeconomic variables are annual total income and education. Other control variables are regional variables, travel time to hospital and regular checkups.

I derive the individual's optimal level of unhealthy behavior as $\beta^* = f$ (Y, t, c, S, p_m ,R, m) from the my theoretical model in the previous chapter; here I construct the econometric model to examine the effects of exogenous variables on lifestyle behaviors:

$$\begin{aligned} Y_i = F(\beta_0 + \beta_1 AGE + \beta_2 GENDER \\ + \beta_3 MARRIED + \beta_4 \sum INCOME + \beta_5 \sum EDUCATION \\ + \beta_6 \sum HEALTH\ STATUS + + \beta_7 \sum HEALTH\ INDICATORS \\ + \beta_8 \sum MEDICAL\ SERVICE\ UTILIZATION \\ + \beta_9 \sum REGIONS + \beta_{10} TIME\ SPEND + \beta_{11} HEALTH\ CHECKING + \varepsilon) \end{aligned} \tag{5.1}$$

Where Y_i represents the dependent variables smoking and alcohol consumption.

Smoking= respondent smokes cigarettes every day: a dichotomous dependent variable, 1 if yes, 0 otherwise;

Alcohol consumption= respondent drinks alcohol: a dichotomous dependent variable, 1 if yes, 0 otherwise;

Age= respondent's age

Gender= dummy variable for gender of respondent; 1 if male, 0 if female;

Married= dummy variable for marital status of respondent; 1 if married, 0 otherwise;

Income= dummy variables for annual total income of respondent;

Income01= 1 if annual total income <= 120,000 NTD, 0 otherwise; (as reference group)

Income02= 1 if 120,000 NTD < annual total income < =300,000 NTD, 0 otherwise;

Income03=1 if 300,000 NTD < annual total income < =600,000 NTD, 0 otherwise;

Income04=1 if annual total income > 600,000 NTD, 0 otherwise;

Education= dummy variables for education level of respondent;

Lessprimary= 1 if education level is below elementary school or illiterate, 0 otherwise; (as reference group)

Primary = 1 if education level is elementary school or can read, 0 otherwise;

Diploma = 1 if education level is junior and senior high school, 0 otherwise;

College= 1 if education level is college or above, 0 otherwise;

Health status= self- reported dummies;

Health01= 1 if "good" and "excellent", 0 otherwise; (as reference group)

Health02= 1 if "fair", 0 otherwise;

Health03=1 if "bad" and "worst", 0 otherwise;

BHP= dummy variable, 1 if ever diagnosed high blood pressure, 0 otherwise;

Diabetes= dummy variable, 1 if ever diagnosed diabetes, 0 otherwise;

Stroke= dummy variable, 1 if ever diagnosed stroke, 0 otherwise;

Cancer= dummy variable, 1 if ever diagnosed cancer, 0 otherwise;

Lungdisease= dummy variable, 1 if ever diagnosed lung disease, 0 otherwise;

Arthritis= dummy variable, 1 if ever diagnosed arthritis, 0 otherwise;

Liverdisease= dummy variable, 1 if ever diagnosed liver disease, 0 otherwise;

Medical care utilization

Inpatient= dummy variable, 1 if received inpatient services in the previous year, 0 otherwise;

Outpatient = dummy variable, 1 if received outpatient services in the previous year, 0 otherwise;

Pharmacy= dummy variable, 1 if visited pharmacy in the previous year, 0 otherwise;

Regions= dummy variables for the respondent's residence;

Northern= 1 if in northern area of Taiwan, 0 otherwise;

Central= 1 if in central area of Taiwan, 0 otherwise;

Southern= 1 if in southern area of Taiwan, 0 otherwise;

Eastern = 1 if in eastern area of Taiwan, 0 otherwise; (as reference group)

Timespend= travel time to hospital, in minutes;

Healthcheck= 1 if received a regular health checkup in the previous year, 0 otherwise;

The descriptive statistics for the dependent variables and the independent variable are presented in Table 5.2 and Table 5.3.

Lifestyles dependent variable

I will use unhealthy (lifestyle) behaviors as dependent variables in my empirical analysis. Furthermore, I will use smoking as a dependent variable in the Probit regression model, where 1 indicates the individual smokes cigarettes every day and 0 indicates non-smoker. Secondly, for alcohol drinker, where 1 indicates the individual drinks alcohol and 0 indicates otherwise.

Independent variables

I follow the previous studies; in grouping independent variables used in the estimation model by four major characteristics: demographic variables, socioeconomic variables, health service utilization and self-reported health status, see Table 5.2 and Table 5.3.

Below, I provide a brief description of the main control variables in my model and predict their relevant relationships with the dependent variables.

1. **Demographic variables**

Age

I would expect that age should have a negative effect on the unhealthy behaviors. Few empirical studies have shown that age has a significant negative impact on unhealthy lifestyle behaviors (i.e., Stanciole 2007). In addition, Ehrlich and Yin (2005) stated that an individual's age is related to his/her mortality risk. Thus a person would have decreased his/her risky behavior as he or she ages. Grossman (1972) and Kenkel (1991) also suggested that the use of preventive service increases with age.

Gender

Most empirical studies have shown that males engage in more unhealthy behavior than females, thus I would expect male to have a positive effect on unhealthy behaviors. This might be due to the preference difference in lifestyle between males and females. However, such generalization will be tested in my study.

Marital status

Marital status is another demographic variable, and I expect the effect on unhealthy behaviors could be negative with marital status since married people may have more concerns about their family.

2. Socioeconomic variables

Income

My theoretical result (result 8 in Chapter 4) shows that an individual's unhealthy lifestyle is positively correlated with income, implying that individual perceives lifestyle behaviors as normal goods. This positive relationship will be tested in empirical model.

Education

Grossman (1972) stated educated people are also more efficient in using health input to generate good health or reduce the probability of incidence from sickness. Therefore, I predict that education and unhealthy behaviors are negatively correlated.

Health status and Health indicators

Self-reported health status indices are often employed as the proxies for individual's risk of becoming sick. Health indicators include high blood pressure, diabetes, stroke, cancers, lung disease, liver disease and arthritis. It is reasonable that people with existing conditions are more likely to reduce their unhealthy behaviors than people without existing condition. However, in the estimation of self-reported health status (S), the self-reported health status variable could be endogenous. In the equation 5.1, there exists a potential endogeneity problem between self-reported health status variables and lifestyle behaviors (smoking and alcohol consumption). If the endogeneity exists, the regression estimates from the lifestyle behavior model could be inconsistent. [11]

In the previous chapter, I showed that health status and unhealthy lifestyle behaviors are negatively correlated; this will be tested empirically.

Medical service utilization

I will use inpatient services, outpatient services, and pharmacy visits as my medical care utilization variables. These are dichotomous variables where 1 indicates utilization in the previous year and 0 indicates otherwise. In my previous theoretical chapter, I showed an ambiguous result on unhealthy behaviors. This result will be tested in my empirical model.

[11] There are two approaches to deal with potential endogeneity under this circumstance. The first approach applies a simultaneous equation in order to estimate the health status model and lifestyle behavior model simultaneously. Another approach applies bivariate *Probit* model which estimates lifestyle behavior model with a standard *Probit* model, while estimating the self-reported health status on the other hand via the ordered *Probit* model.

3. Other control variables

Regional variable

There are four regional dummy variables: Northern area, Central area, Southern area, and Eastern area, showing where the individual lives in Taiwan. I predict that people living in the Eastern area use less prevention and engage in more unhealthy behaviors because eastern area of Taiwan is less developed and resources are less concentrated than other areas.

Time spend

Travel time to the hospital is also employed as an independent variable. I predicted it to be negatively correlated with unhealthy behaviors.

Regular health checkup

Regular health checkup is another important independent variable in this model, I expect it to have a negative impact on unhealthy lifestyle choices.

5.3 Econometric method

In order to test and analyze the theoretical results on lifestyle behaviors from the previous chapter, I first introduce the univariate probit model to measure the effects on each unhealthy lifestyle behavior independently.

5.3.1 Univariate standard *Probit* model for lifestyle behavior

When a dichotomous dependent variable is regressed on the explanatory variables in my model, a nonlinear equation may be a better fit than ordinal least square (OLS) estimation. I run the regression model using the 6^{th} wave of 2007 and the 2^{nd} wave of 1993 datasets from the Survey of Health and Living Status of the Middle-Aged and Elderly in Taiwan. I employ a univariate standard *Probit* model in each lifestyle behavior equation. The univariate standard

Probit model is usually estimated by maximum likelihood estimation. Maddala (1983) and Jones (2000) have shown that the *Probit* model can be given a latent variable interpretation.

Let,

$$y_i = 1 \qquad \text{if } y_i^* > 0,$$

$$y_i = 0 \qquad \text{otherwise,}$$

Where, $$y_i^* = x_i\beta + \varepsilon_i$$

And, for a symmetrically distributed error term ε with distribution function F (.),

$$Prob\ (y_i = 1 \mid x_i) = Prob(y_i^* > 0/x_i) = Prob(\varepsilon_i > -x_i\beta) = F(x_i\beta) = \int_{-\infty}^{\frac{x\beta}{\sigma}} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} \mathrm{dt}$$

$$Prob\ (y_i = 0 \mid x_i) = 1 - F(x_i\beta)$$

In my model, y_i^* represents the unhealthy lifestyle behavior choice, with the assumption that the error term ε_i has a standard normal distribution[12],i.e, $\varepsilon_i \sim N(0,1)$. In addition, $F(x_i\beta)$ represents the standard normal cumulative distribution function. In this model, the *Probit* function provides the probability that the event occurs, and one minus this function provides the probability that the event will not occur. The likelihood is thus the product of *Probit* functions for those observations that the event occurred multiplied by the product of one-minus-the *Probit* functions for those observations that the event did not occur. Moreover, the log-likelihood for the sample of independent observation is as follows:

$$\log \mathrm{L} = \textstyle\sum_i \{y_i \log[F(x_i\beta)] + (1 - y_i) \log[1 - F(x_i\beta)]\}$$

[12] When the error term ε_i is assumed to take a standard logistic distribution, this is the logit model and the probability of the medical use will become $(y_i = 1 \mid x_i) = Prob(y_i^* > 0 \mid x_i) = \frac{e^{x_i\beta}}{1+e^{x_i\beta}}$. The two models produce very similar results in practice (Greene, 2008)

In interpreting the results from the *Probit* model, the change in the predicted probability associated with changes in the explanatory variables is often measured by the marginal effects rather than the estimated coefficients. This is because the estimated (index) coefficients in the *Probit* model are defined up to some scalar normalization, which usually measure the change in the unobservable dependent variable associated with a change in one of the explanatory variables. The formula of the marginal effect of a continuous independent variable is as follows:

$$\frac{\partial Prob(y_i = 1 \mid x_i)}{\partial x_i} = \frac{\partial F(x_i\beta)}{\partial x_i} = \beta \times \phi(x_i\beta)$$

Where $\phi(x_i\beta)$ is the probability density function.

If the independent variable (x_i) is a discrete or a dummy variable in a binary choice model (like treatment effect), then the formula of the marginal effect of this dummy variable is as follows:

$$\frac{\partial Prob(y_i = 1 \mid x_i)}{\partial x_i} = Prob(y_i = 1 \mid x_i = 1) - Prob(y_i = 1 \mid x_i = 0)$$
$$= F(x_i\beta)_{x_i=1} - F(x_i\beta)_{x_i=0}$$

5.3.2 The seemingly unrelated bivariate *Probit* model

My initial interest was to examine Taiwan's National Health Insurance system's effects on individual lifestyle behavior. However, the univartiate standard probit regression model would produce unbiased but inefficient estimators for exogenous variables because it assumes the error terms are not correlated with each other, also it ignores the unobservable heterogeneity between the two equations. Kenkel (1991) and Courbage and Coulon (2004) modeled each lifestyle behavior with health insurance as an independent variable. However, both papers ignored that individual decisions of buying health insurance are correlated with lifestyle behaviors. Having both observable and unobservable factors together in these types of model generally produces biased results, as in the two papers mentioned above. But in my univariate standard *Probit* model (section 5-3-1), the error terms of both lifestyle choice equations are likely to be correlated over time, and cross behaviors. Since unobservable factors may affect both the propensity to smoking and alcohol consumption, this would make the estimators inefficient result. Therefore, the first standard *Probit* model that ignored the unobservable individual heterogeneity would also lead to inefficient result.

An alternative approach to control for unobservable heterogeneity is to consider a seemingly unrelated bivariate *Probit* model, as it provides a way of dealing with two separate binary dependent variables. This model takes two independent binary *Probit* models into account and estimates them together. Allowing for correlation (ρ) between the error terms of the two equations recognizes the fact that there may be unobservable individual characteristics that influence both smoking and alcohol consumption. I follow Jones. et al (2007) and Greene's (2008) approach to employ a seemingly unrelated bivariate *Probit* model as my second econometric model in order to identify the effects of Taiwan's National Health Insurance on lifestyle behaviors. Assuming that smoking is identified by the latent variable y_{i1}^* and alcohol consumption is identified by another latent variable y_{i2}^*, the seemingly unrelated bivariate *Probit* model for smoking can be given as:

$$y_{i1}^* = \beta_1 x_{i1} + \varepsilon_{i1}$$

$$y_{i1} = \begin{cases} 1 & if\ y_{i1}^* > 0 \\ 0 & ,\ otherwise \end{cases}$$

where x_{i1} refers to a vector of observed determinants of smoking, β_1s are parameter coefficients, and ε_{i1} is a random error term for smoking.

Analogously, the latent variable y_{i2}^{*} for the propensity of alcohol consumption is measured by:

$$y_{i2}^{*} = \beta_2 x_{i2} + \varepsilon_{i2}$$

$$y_{i2} = \begin{cases} 1 & if\ y_{i2}^{*} > 0 \\ 0 & ,\ otherwise \end{cases}$$

where x_{i2} refers to a vector of observed determinants of alcohol consumption, β_2 s are parameter coefficients, and ε_{i2} is a random error term for alcohol consumption.

These explanatory variables x are already discussed in section 5-3-1. In addition, attention should be paid to the two error terms since we expect them to be correlated with each other. The error terms in the two latent equations have a standard bivariate normal distribution, giving a seemingly unrelated bivariate *Probit* model, so that $E(\varepsilon_{i1}) = E(\varepsilon_{i2}) = 0$, $Var(\varepsilon_{i1}) = Var(\varepsilon_{i2})$=1 , and $Cov\ (\varepsilon_{i1}, \varepsilon_{i2}) = \rho$.

The correlation between the error terms ($\varepsilon_{i1}\ and\ \varepsilon_{i2}$) is comprised of two components: (1) unobserved individual heterogeneity (μ_i); and (2) a constant (u_i) for each model:

$$\varepsilon_{i1} = \ \mu_i + u_{i1}$$

$$\varepsilon_{i2} = \ \mu_i + u_{i2}$$

Assuming that all three types of error terms follow normal distribution, then $\varepsilon_{i1}\ and\ \varepsilon_{i2}$ will be related to each other.

Therefore, I test the following null and alternative hypotheses: $H_0: \rho = 0$ and $H_a: \rho \neq 0$. If the correlation coefficient equal to 0 ($\rho = 0$), then I can estimate the two independent *Probit* separately. Then one could interpret that the factors affecting the probabilities of smoking and alcohol consumption are exogenous. For the separate probits, the joint likelihood function is the product of the two separate marginal likelihoods. For example, if two random variables are independent, then their joint probabilities are the product of their marginal probabilities. So

$Pr(y_{i1} = 1, y_{i2} = 1) = F(\beta_1 x_{i1}) \times F(\beta_2 x_{i2})$. Maddala (1983) shows that the log-likelihood function of the bivariate *Probit* model becomes the sum of log-likelihood functions of two separate probits, and the coefficients are obtained by estimating the two equations separately.

However, if the test result is $\rho \neq 0$ (or the two error terms are not independent), then we have the evidence that the unobservable factors influence the probability of smoking, which also influence the probability of alcohol consumption. In this case, I can estimate the smoking and alcohol consumption of the two *Probit* equations jointly by using maximum likelihood estimation (MLE) to obtain consistent parameter when the error terms are correlated. Following Greene (2008), this is accomplished by first denoting $\Phi_2(\beta_1 x_1, \beta_2 x_2, \rho)$ as the bivariate standard normal distribution with a correlation coefficient parameter ρ, then the joint pdf will become :

$$\phi_2 = \phi(\varepsilon_1, \varepsilon_2) = \frac{1}{2\pi\sqrt{1-\rho^2}} \exp[-\frac{1}{2} (\frac{\varepsilon_1^2 + \varepsilon_2^2 - 2\rho\varepsilon_1\varepsilon_2}{1-\rho^2})]$$

Therefore, the joint cdf of bivariate normal distribution will be:

$$\Phi_2(\beta_1 x_1, \beta_2 x_2, \rho) = \boldsymbol{\Phi}(\varepsilon_1, \varepsilon_2) = \int_{\varepsilon_1} \int_{\varepsilon_2} \phi_2(\beta_1 x_1, \beta_2 x_2, \rho) d\, \varepsilon_1 d\varepsilon_2$$

By testing the hypothesis that $\rho = 0$, one would be able to confirm whether the bivariate *Probit* model is a better fit than a separate *Probit.* One approach would be to use a likelihood ratio (LR) test to compare the sum of log-likelihoods of the two separate *Probit* equations with the log-likelihood of the bivariate *Probit* model. Another approach to test $H_0: \rho = 0$ is to perform a Wald test. Sajaia (2004) strongly rejected the null hypothesis in the bivariate *Probit* model by performing both LR test and Wald tests.

5.3.3 Difference in difference model

Furthermore, I use a difference-in-difference (DD) method to compare how these effects change before and after the implementation of Taiwan's national health insurance system. The intent is to analyze the impact of public health insurance on lifestyle behavior, and how this impact changes over time in response to the National Health Insurance reform from 1995. To accomplish this goal, I compare the 2nd wave of 1993 dataset with the 6th wave of 2007 dataset. This methodology is based on basic comparisons – before and after the policy change for treatment and control groups, controlling for other relevant factors. The empirical model is set up in the following form:

$$Y_i = \alpha_0 + \alpha_1 * insurance + \alpha_2 Y2007_i + \alpha_3 insurance * Y2007_i + \beta X_i + \varepsilon$$

In the equation above, Y_i are smoking, and alcohol consumption indicators. Insurance is a dummy variable where 1 indicates an individual has public health insurance in 1993, 0 otherwise. α_1 captures the time-independent difference in the comparison of individuals, i.e., an individual who has public health insurance versus an individual who did not have it. $Y2007_i$ is a dummy variable (1 if observations in 2007, 0 if observations in 1993), this was the year when Taiwan's Department of Health conducted a survey of post-NHI in the series of Surveys of Health and Living Status of Middle Age and Elderly in Taiwan. Therefore, α_2 captures the difference in the pre-NHI year 1993 and post- NHI year 2007. In addition, α_3 is the coefficient on the interaction term, $insurance * Y2007_i$, it captures the difference-in-difference estimates of the impact of Taiwan's National Health Insurance reform since 1995. Table 5.4 illustrates the difference-in-difference methodology and how it corresponds to the estimated equations.

Table 5.4. Difference -in-difference methodology and estimation of the coefficients

	Difference -in-difference methodology	
	With insurance	Without insurance
Before (Y1993)	$\alpha_0 + \alpha_1$	α_0
Y2007	$\alpha_0 + \alpha_1 + \alpha_2 + \alpha_3$	$\alpha_0 + \alpha_2$
Difference (1) (Y2007-Y1993)	$\alpha_2 + \alpha_3$	α_2
Difference-in-difference (Diff $_{\text{treatment 2007}}$- Diff $_{\text{control 1993}}$)	α_3	

However, when the dependent variable is a discrete variable (nonlinear), the interaction effect usually cannot be evaluated by looking at the signs of the magnitude and statistical significance of the coefficient on the interaction term if estimating by *Probit* model. Therefore, it is better to rewrite the difference-in-difference model as the following:

$$Prob\ (y_i = 1 \mid x_i) = Prob(y_i^* > 0/x_i) = F(x_i\beta)$$

$$= F(\alpha_0 + \alpha_1 * insurance + \alpha_2\, Y2007_i + \alpha_3 insurance * Y2007_i + \ \beta X_i + \varepsilon)$$

where $F(x_i\beta)$ represents the standard normal cumulative distribution function. The interaction effect of the Y2007 and the Pre-NHI on the probability of using unhealthy behavior variables should be shown by a nonlinear model[13].

[13] For more details of interaction effect of dummy variable in a nonlinear model, please refer to Ai and Norton (2003), and Norton et al. (2004).

Besides the three major explanatory variables, I also control for a set of variables X_i reflecting individual demographic, socioeconomic characteristics, self-reported health status, health indictors, health care utilization, and other control variables in my study, these variables are already discussed in the previous section.

Table 5.2 Summary Statistic of Variables in 1993 (Sample = 3155)

Variables	Label	Min.	Max.	Mean.	Std. Dev.
Smoking	A dichotomous dependent variable	0	1	0.2887	0.4532
Alcohol Consumption	A dichotomous dependent variable	0	1	0.1762	0.3810
Age	Age of respondent	61	94	71.7448	5.7839
Gender	Gender of respondent, Dummy variable	0	1	0.5641	0.4959
Married	Marital status of respondent, Dummy Var.	0	1	0.6849	0.4646
Income 01	Dummy variable for low income group	0	1	0.5768	0.4941
Income 02	Dummy variable for middle income group	0	1	0.2250	0.4176
Income 03	Dummy variable for middle-high income group	0	1	0.1619	0.3684
Income 04	Dummy variable for high income group	0	1	0.0253	0.1572
Lessprimary	Edu. Level below elementary school, Dummy var	0	1	0.4729	0.4993
Primary	Edu. Level is elementary school, Dummy var.	0	1	0.3546	0.4784
Diploma	Edu. Level is junior and senior school, Dummy var	0	1	0.1445	0.3516
College	Edu. Level is college or above, Dummy var.	0	1	0.0278	0.0164
Health 01	Good and excellent for health status, Dummy var.	0	1	0.3968	0.4893
Health 02	Fair condition for health status, Dummy var.	0	1	0.3274	0.4693
Health 03	Bad and worse for health status, Dummy var.	0	1	0.2167	0.4121
HBP	Ever diagnosed high blood pressure, Dummy var.	0	1	0.3011	0.4588
Diabetes	Ever diagnosed diabetes, Dummy variable	0	1	0.1052	0.3068
Stroke	Ever diagnosed stroke, Dummy variable	0	1	0.0687	0.2531
Cancer	Ever diagnosed cancer, Dummy variable	0	1	0.0171	0.1297
Liverdisease	Ever diagnosed liver disease, Dummy variable	0	1	0.0573	0.2325
Lungdisease	Ever diagnosed lung disease, Dummy variable	0	1	0.1606	0.3673
Arthritis	Ever diagnosed arthritis, Dummy variable	0	1	0.2450	0.4301
Inpatient	Received inpatient service, Dummy variable	0	1	0.1787	0.3832
Outpatient	Received outpatient service, Dummy variable	0	1	0.6943	0.4607
Pharmacy	Visited pharmacy, Dummy variable	0	1	0.3955	0.4890
Eastern	Live in eastern area of Taiwan, Dummy variable	0	1	0.0503	0.2187
Northern	Live in northern area of Taiwan, Dummy variable	0	1	0.3045	0.4603
Central	Live in central area of Taiwan, Dummy variable	0	1	0.3359	0.4724
Southern	Live in southern area of Taiwan, Dummy variable	0	1	0.3090	0.4621
Timespend	Travel time to hospital (in minutes)	0	600	36.1961	44.4307
Healthcheck	Received a regular health checkup, Dummy variable	0	1	0.2982	0.4575

Table 5.3 Summary Statistic of Variables in 2007 (Sample = 4534)

Variables	Label	Min.	Max.	Mean.	Std. Dev.
Smoking	A dichotomous dependent variable	0	1	0.1764	0.3812
Alcohol Consumption	A dichotomous dependent variable	0	1	0.2865	0.4521
Age	Age of respondent	54	106	68.8696	10.7365
Gender	Gender of respondent, Dummy variable	0	1	0.5008	0.5000
Married	Marital status of respondent, Dummy Var.	0	1	0.7216	0.4482
Income 01	Dummy variable for low income group	0	1	0.2801	0.4491
Income 02	Dummy variable for middle income group	0	1	0.3815	0.4858
Income 03	Dummy variable for middle-high income group	0	1	0.1782	0.3827
Income 04	Dummy variable for high income group	0	1	0.1354	0.3422
Lessprimary	Edu. Level below elementary school, Dummy var	0	1	0.2827	0.4503
Primary	Edu. Level is elementary school, Dummy var.	0	1	0.4161	0.4929
Diploma	Edu. Level is junior and senior school, Dummy var	0	1	0.2516	0.4340
College	Edu. Level is college or above, Dummy var.	0	1	0.0494	0.2167
Health 01	Good and excellent for health status, Dummy var.	0	1	0.3405	0.4739
Health 02	Fair condition for health status, Dummy var.	0	1	0.3687	0.4825
Health 03	Bad and worse for health status, Dummy var.	0	1	0.2906	0.4541
HBP	Ever diagnosed high blood pressure, Dummy var.	0	1	0.3967	0.4892
Diabetes	Ever diagnosed diabetes, Dummy variable	0	1	0.1676	0.3735
Stroke	Ever diagnosed stroke, Dummy variable	0	1	0.0648	0.2462
Cancer	Ever diagnosed cancer, Dummy variable	0	1	0.0370	0.1889
Liverdisease	Ever diagnosed liver disease, Dummy variable	0	1	0.1018	0.3025
Lungdisease	Ever diagnosed lung disease, Dummy variable	0	1	0.1056	0.3074
Arthritis	Ever diagnosed arthritis, Dummy variable	0	1	0.1929	0.3946
Inpatient	Received inpatient service, Dummy variable	0	1	0.1740	0.3791
Outpatient	Received outpatient service, Dummy variable	0	1	0.8868	0.3168
Pharmacy	Visited pharmacy, Dummy variable	0	1	0.3328	0.4712
Eastern	Live in eastern area of Taiwan, Dummy variable	0	1	0.0317	0.1753
Northern	Live in northern area of Taiwan, Dummy variable	0	1	0.3041	0.4601
Central	Live in central area of Taiwan, Dummy variable	0	1	0.3365	0.4725
Southern	Live in southern area of Taiwan, Dummy variable	0	1	0.3275	0.4693
Timespend	Travel time to hospital (in minutes)	0	360	22.7052	24.0856
Healthcheck	Received a regular health checkup, Dummy variable	0	1	0.5191	0.4996

Chapter 6. Regression Results

6.1 Results from the Univariate Probit Model

I use the univariate Probit model to investigate the impacts of national health insurance on lifestyle behaviors – smoking and alcohol consumption. I run the regression models using data from the 6th wave of SHLE (2007) and the 2nd wave of SHLE (1993) separately. The results of the cross- sectional regression are reported in Table 6.1 and Table 6.2.

6.1.1 Determinants of smoking

With the standard Probit model specification, the effects of the regression result on smoking are shown in Table 6.1. The marginal effects of the regression equation, the corresponding standard errors and other important values of the estimations are also presented. Each wave of SHLS was run individually as an independent data set.

Age is negative and statistically significant in both the 2007 and the 1993 models. This negative correlation between smoking and age suggests that as people aged, they engage in less risky or unhealthy behaviors (in this case smoking) in order to maintain health and to sustain lifespan. This is consistent with my prediction. In addition, *Gender* is positive and statistically significant in both 2007 and 1993. The result shows that males are 31.9 % in 2007 and 43.5% in 1993 more likely to be smokers than females. This suggests that males engage in more unhealthy behavior than females confirming to the social now in society's like Taiwan.

Married is statistically significant and negatively related to smoking in 2007 only. The result shows that married people are 4.2 % less likely to be smoker than the unmarried. But *Married* was not significant for the 1993 model.

The effect of *Income level* on smoking is also tested. I specify four income dummy variables: *Income01, Income02*, *Income03 and Income04*, with *Income01* (low income group) as the reference group. My results show that *Income level* is negative but not statistically significant for both 2007 and 1993. This is not consistent with my theoretical result. I will explore possible reasons behind this in my conclusion and discussion sections.

The effect of *Education level* is also tested in my model. The four education level dummy variables are *Lessprimary*, *Primary, Diploma* and *College*, with *Lessprimary* as the reference group. All of them are negatively correlated with smoking; implying more- educated people are less likely to smoking compared with lower-educated people. Nevertheless, only *Diploma* and *College* are statistically significant. One can interpret that more-educated people tend to take better care of themselves due to better access to health information. This is consistent with my prediction.

The effect of *Health status* on smoking is also tested. The three health status dummies are *Health01, Health02* and *Health03*, with *Health01 (*good and excellent) as the reference group. As to the result, only *Health02 (fair*) in 2007's model is positive and statistically significant, the rests are negative and /or not significant, implying that less healthy people are more likely to be smokers compared with good and excellent people. This result is inconclusive and not consistent with my theoretical result. One possible explanation for this inconsistency is that self-reported health status is a poor indictor on one's true health.

Health indictor variables, such as high blood pressure (HBP), *Diabetes, stroke, cancer, liver disease* and *arthritis*, are also tested in my model. The variables *HBP*, *cancer* and *liver disease* are negative and statistically significant. *Diabetes* and *Stroke* are negative but not statistically significant for the 2007 model. For the 1993 model, the variables *HBP*, *Stroke* and *liver disease* are negative and significant. *Cancer* is also negative but not significant. However, *Diabetes* and *arthritis* are positive but not significant in the 1993 model.

The Medical service utilization variables include *inpatient services, outpatient services*, and *pharmacy visits*. They have ambiguous effects on smoking according my theoretical result. Empirically, I find that *inpatient* and *outpatient* are negative but not statistically significant. Meanwhile, *pharmacy* is positive but not significant in the 2007 model. However, for the 1993 model, the results for *inpatient* and *outpatient* are negative and statistically significant. *Pharmacy visit* is positive and significant.

I predicted that people living in the Eastern area use less prevention and engage more in unhealthy behaviors because the eastern area of Taiwan is relatively less developed, with less concentrated health care resources than the other areas. I specify four regional dummy variables – *Northern, Central, Southern* and *Eastern,* with *Eastern* as the reference group. According to the empirical result, the three dummy variables are all negative and statistically significant for both 2007 and 1993, meaning people living in the Eastern area (the base category) are more likely to smoke than the other three areas. This is consistent with my prediction.

Timespend (travel time to the hospital) is predicted negatively correlated with smoking because of transportation cost. In my empirical result, *Timespend* is negative and statistically significant for the 2007 model only. As for 1993, it is negative but not significant. Finally, the dummy *Healthcheck* is expected to have a negative impact on smoking. The result shows that *Healthcheck* is negative and statistically significant in both 2007 and 1993. This suggests that people who did regular health checkup in the previous year are less likely to smoke. This is consistent with my prediction.

In short, the regression results of smoking equations are not too dissimilar between 1993 and 2007. *Age, Married, Education level and Healthcheck* are negatively and statistically significant for both models. However, *Income level* and *medical service utilization* variables are not found any significant effect in 2007 model. Under univartiate probit model, the smoking equation's results may fail to capture the unobservable element between smoking and alcohol consumption models. It may also mean that *Income level* and *medical service utilization* variables are less reliable and the results are not satisfactory in this model.

6.1.2 Determinants of alcohol consumption

Table 6.2 reports the results from the univariate probit regression on alcohol consumption. Variables' marginal effects, standard errors, and other statistics are presented. Analogous to the smoking regression, I run each SHLS dataset (1993 and 2007) individually.

The variable *Age* is a negative and statistically significant determinant on *Alcohol consumption* for both the 2007 and 1993 models, suggesting that as people aged, they tend to decrease their risky behaviors such as drinking, in order to maintain health and sustain lifespan. This is consistent with my prediction. In addition, *Gender* does have a positive and statistically significant effect on alcohol consumption in both 2007 and 1993. The empirical results show that males are more likely (29.2 % in 2007 and 22.5% in 1993) to drink than female, suggesting that males engage in more unhealthy behavior such as alcohol consumption than females, and it is consistent with my prediction. The variable *Married* is negative but does not appear to be statistically significant in both 2007 and 1993.

The effect of *Income level* on alcohol consumption is also tested in my model. I specify four dummy variables – *Income01, Income02*, *Income03, and Income04* – for the income categories.

Income01 (low income group) is the reference group. I find *Income03* (middle-high income group) and *Income04* (high income group) are positive and statistically significant in 2007, and it is consistent with my theoretical result. However, in 1993, I find that *Income03* to be positive and significant. Nevertheless, *Income04* is positive but not significant.

For *Education level*, I specify four dummy variables, *Lessprimary*, *Primary, Diploma* and *College*, with *lessprimary* as reference group. All of them are significant and positively correlated with alcohol consumption in 2007. This is consistent with my prediction. However, they are not significant in 1993.

The effect of health status on alcohol consumption is also tested in my model. There are three dummy variables – *Health01, Health02* and *Health03* – for the health status categories. *Health01* (good and excellent health status) is the reference group. The results show that both *Health02* and *Health03* are negative and statistically significant for both the 2007 and 1993 models, which is consistent with my theoretical result.

My health indictor variables are *high blood pressure (HBP), Diabetes, stroke, cancer, lung disease and arthritis.* The results show that *stroke* and *cancer* are significant and negatively affecting alcohol consumption in 2007. On the other hand, *lung disease* and *arthritis* are positive and significant in 2007. As for the 1993 result, I find *HBP* and *Stroke* to be negative and significant. *Diabetes, cancer* and *lung disease* are also negative but not significant. Just as in the 2007 model, *arthritis* is also positive and significant in 1993.

Medical service utilization includes *inpatient services, outpatient services, and pharmacy visits*. According to my theoretical result, medical service utilization has an ambiguous effect on alcohol consumption. In my empirical results, I find that *inpatient* and *outpatient* are negative and statistically significant; however, *pharmacy visit* is positive and significant in 2007. In 1993, only *inpatient* is negative and statistically significant.

I predicted that people living in the Eastern area used less prevention and engage in more unhealthy behaviors than the other areas. The four regional dummy variables are *Northern, Central, Southern* and *Eastern*, with *Eastern* as reference group. According to the empirical result, in the 2007 model only *Central* is negative and statistically significant; in 1993, however, all dummies are negative and significant. This implies that people living in the Eastern area are more likely to consume alcohol. The result from the 1993 model is consistent with my prediction. *Timespend* (travel time to the hospital) should have a negative effect on alcohol consumption. In my empirical result, *Timespend* is negative and statistically significant in 2007. On the other hand, *Timespend* is negative but not significant in 1993. Finally, *healthcheck* is expected to have a negative impact on alcohol consumption. I find that *healthcheck* is positive and statistically significant in 2007; while in 1993, it is negative but not significant. This implies that people who had a health checkup during the past year are more likely to consume alcohol. This empirical result seemly goes against most common logic. I will further explore the reasons behind this finding in the conclusion and discussion sections.

In short, the regression results of alcohol consumption equations are not too dissimilar between 1993 and 2007. *Age and Stroke* are negatively and statistically significant for both models. However, *Income level, education level, health status, Timespend* and *medical service utilization* variables are all found significant effect in 2007 model only. Under univariate *Probit* model, the alcohol consumption equation's results may also fail to capture the unobservable element between smoking and alcohol consumption models. It may cause that *Health status* and *Income level* variables are less reliable in 1993 and the results are not be satisfied in this model.

Finally, compared with smoking and alcohol consumption equations in 2007 from Table 6.1 and Table 6.2, the results show that both *Education level* and *Healthcheck* are negative and statistically significant effect on the smoking model, which are not consistent result with both positively and statistically effect on the alcohol consumption model[14].

6.2 Results for Seemingly Unrelated Bivariate Probit Model

The univariate probit results from the previous section (6.1) aimed to compare the determinants of smoking and alcohol consumption between two data years (1993 and 2007). This section presents the results for the bivariate probit regression models. Unlike the univariate probit model, the bivariate probit model estimates the smoking and alcohol consumption equations simultaneously. This approach allows the estimation on the likelihood of smoking and alcohol consumption at the same time. The bivariate probit model allows for the error terms of the two equations (smoking and alcohol consumption) to be correlated via some unobservable individual characteristics (correlation coefficient ρ). It also evaluates a bi-dimensional integral over the two distributions of the error terms. Therefore, the Bivariate Probit model is a better methodology than the univariate probit model because it captures precisely the unobservable exogeneity

6.2.1 Testing for unobserved exogeneity

Prior to presenting the regression results from the Bivariate Probit model, I first test whether

[14] The univariate *Probit* model's results for alcohol consumption are generally the same as (or not too dissimilar with) the results from the ordered *Probit* model. Indicating that the overall conclusion from my univariate *Probit* model need not to be altered based on merely expanding the original drinking variable (1=drinker, 0=non-drinker) to a more detailed set of drinking variables. For *Income* and *education level*, both models are positive and statistically significant, except for the heavy alcohol consumption level (level 5) in the ordered *Probit* model, in which the results showed a weak significant (at 10 %) for *income* and *education level*, see appendix 5 for more detail.

Bivariate Probit is a better fit than univariate probit by performing a likelihood ratio (LR) test and Wald test. Testing unobserved exogeneity in the Bivariate Probit model consist of seeing whether the correlation coefficient (ρ) between the two error terms is zero or not. The null and alternative hypotheses are $H_0: \rho = 0$ and $H_a: \rho \neq 0$, where ρ represents the correlation coefficient between the residuals from the smoking and alcohol consumption equations. If the null H_0 is not rejected, or I cannot rule out $\rho = 0$, then the results from the bivariate *Probit* model is analogous to the univariate *Probit* model. If that is the case, the error terms for smoking and alcohol consumption are independent. This implies that the unobserved factors affecting the probabilities of being a smoker and alcohol drinker are not significantly correlated.

On the other hand, if H_0 is rejected, or $\rho \neq 0$, it means that the error terms for the two equations are not independent. This implies that there is evidence of unobservable factors affecting both probabilities of being a smoker and alcohol drinker. Then, the two *Probit* equations need to be estimated jointly via the bivariate *Probit* model.

Table 6.3 reports the results of the estimated correlation coefficient (ρ) between the two error terms (smoking and alcohol consumption equations) and 3 test statistics (Z statistic, LR test and Wald test) from the bivariate probit model. As shown in Table 6.3, the estimated correlations coefficient (ρ) are 0.3518 and 0.2592 for 1993 and 2007, respectively. I interpret that the correlation between the error terms in the smoking and the alcohol consumption equations to be positive, suggesting that smoking and alcohol consumption share some unobservable determinants together. Furthermore, the results of the unobserved exogeneity tests (Z statistic, LR test and Wald test) are shown. The LR test and the Wald test as shown suggest that the estimate correlation coefficients in both 1993 and 2007 are both statistically significant from zero. The null hypothesis $\rho \neq 0$, is rejected at the 1 % level for both smoking and alcohol consumption equations. This result suggests that the bivariate *Probit* model is an appropriate methodology; if two independent probit models are used instead, the results generated will be biased. Therefore, the bivariate *Probit* model is applied in the following section.

6.2.2 Seemingly Unrelated Bivariate Probit Regressions Results for 2007

Because over 99% of the population enrolled in the NHI program in 2007, the results can be interpreted as the determinants of smoking and alcohol consumption under NHI, rather than looking at NHI's effect as a whole. Table 6.4 presents the estimated coefficient results, the corresponding standard errors and other important statistics from the smoking and drinking Bivariate Probit models side by side. This allows me to examine the joint determinants of smoking and alcohol consumption for 2007. With respect to demographic variables, *Age* is statistically significant and negative at 1% level in both the smoking and alcohol consumption models. From Table 6.4, one can see that seniors are less likely to be smokers or alcohol drinkers. *Gender* is statistically significant and positive in both models; it implies that males are more likely to be smokers or drinkers than females. *Married* is statistically significant and negatively related to smoking only, meaning married people are less likely to be smokers.

With respect to socioeconomic variables, comparing to the low income reference group, only people belonged to *Income03* (middle- high income group) and *Income04* (high income group) are more likely to be drinkers. As to education level, people with higher education are significantly less likely to be smokers; instead, but are more likely to be drinkers.

With respect to health status and health indicators, comparing to the reference group *Health01* (good and excellent), *Health02* (fair) is positive and statistically significant at 10 %

level on smoking, suggesting that people who have self-reported a fair health status are more likely to be smokers. As for alcohol consumption, those self-reported either fair or bad and worse are less likely to be alcohol drinkers. People with, or experienced either high blood pressure (*HBP*) or liver disease are less likely to be smokers; while people who had experienced a stroke are less likely to be drinkers. People with, or have experienced cancer are less likely to be smokers or drinkers. Lastly, people with or have experienced arthritis are more likely to be drinkers.

With respect to medical service utilization, people who have received inpatient or outpatient services in the past year are less likely to be drinkers. This is a possible example of the moral hazard effect on medical service utilization. Recall that copayment rates are set up in order to control medical utilization. Those who have received inpatient or outpatient services in the past year would have had personal experience with paying for various copayments associated with their visits. It is possible that these patients adjusted their unhealthy behavior such as drinking in light of the cost burden from copayments. With respect to the geographic variables, comparing to *Eastern* area, people from *Northern* area and *Southern* area are less likely to be smokers only; while people from *Central* area are less likely to be smokers and drinkers.

Timespend (travel time to the hospital) is statistically significant and negatively correlated with smoking and alcohol consumption. This suggests that the more time it takes for people to get to the hospital, the less likely they will smoke and drink. Lastly, there are some contradicting results for the *Healthcheck* variable: as shown in Table 6.4, people who had regular health checkup in the past year are less likely to smoke, however, but are more likely to drink.

6.2.3 Seemingly Unrelated Bivariate Probit Regressions Results for 1993

Apart from some exceptions, results from the 1993 model are not too dissimilar to those from 2007. For example, in the smoking model in 1993, the medical service utilization variables — inpatient and outpatient services— are negative and statistically significant. However, health status is not significant. For alcohol consumption in 1993, education levels are not significant but the regional variables are statistically significant. These aforementioned results are different compared to 2007's model.

Results of the Bivariate Probit models in 1993 are presented in Table 6.5. With respect to demographic variables, *Age* is negative and statistically significant at 1% in both smoking and alcohol consumption models; this suggests that seniors are less likely to smoke or drink in 1993. *Gender* is positive and statistically significant in both models, implying that males are more likely to smoke or drink. *Married* is statistically significant and negatively correlated to smoking only, meaning married people are less likely to be smokers in 1993.

With respect to socioeconomic variables, comparing to the low income reference group, only those belonged in *Income03* (middle- high income group) are more likely to be drinkers. As to education levels, people with higher educations (*diploma* and *college*) are significantly less likely to smoke compared to the less-educated.

With respect to health status and health indicators, comparing to *Health01* (good and excellent), *Health03* (bad and worse) is negative and statistically significant at 1 % in the alcohol consumption model, implying that people who self-reported their health status as "bad and worse" are less likely to be alcohol drinkers in 1993. *HBP* is significant and negatively correlated with smoking and alcohol consumption. This suggests that people with, or have experienced high blood pressure (*HBP*) are less likely to smoke or drink in 1993. People with, or have experienced liver disease are less likely to be smokers; on the other hand, people with, or have experienced arthritis are more likely to drink.

With respect to medical service utilization, people who received inpatient services in the previous year are less likely to be smokers or drinkers in 1993; nevertheless, people who received outpatient services in the previous year are less likely to be a smoker only. Lastly, someone who had visited pharmacy in the previous year is more likely to be a smoker in 1993.

With respect to other control variables, comparing to *Eastern* area, people from the *Northern*, *Southern* and *Central* area are less likely to be smokers or drinkers. *Timespend* (travel time to the hospital) does not show any significant correlation with smoking or alcohol consumption in the 1993 models. For *Healthcheck*, people who had regular health checkups during the previous year are less likely to be smokers.

6.3 Results for Difference-in-difference model

A difference-in-difference model is used to investigate the impacts of Taiwan's national health insurance on lifestyle behaviors (smoking and alcohol consumption) over 1993-2007. I pooled 1993's dataset (usable sample size = 3,124 respondents) and 2007's dataset (usable sample size = 1,237 respondents) together. *Insurance* is an indicator variable with 1 = covered by public (or national) health insurance and 0 = otherwise. *Year* is another dummy, with 1 representing the post-reform period (2007) and 0 for the pre-reform period (1993), this is a proxy for NHI policy implementation. *Interaction* is the interaction term between *Year* and *Insurance*. This interaction term is intended to capture, if any, the effect of moral hazard from NHI policy change.

6.3.1 National Health Insurance effect on lifestyle behaviors

Table 6.6 shows the difference-in-difference results for both smoking and alcohol consumption models. Variables' marginal effects, along with the corresponding standard errors and other statistics are presented. First, the *Insurance* status dummy reflects the public health insurance's effect on lifestyle behaviors. However, no significant public health insurance effect is found from either the smoking or the alcohol consumption model, since the coefficient on *Insurance* is negative but not significant. Therefore, there is no evidence that people covered by public health insurance engage more in unhealthy behaviors, implying a lack of evidence for the moral hazard phenomenon in which people covered by public health insurance engage in more unhealthy behavior.

I find that the marginal effect of the dummy variable *Year* to be significant and negatively (7.38%) correlated with smoking. This means that people covered by national health insurance are less likely to be smokers in 2007, compared with the sample in 1993. However, the marginal effect of *Year* is statistically significant and positive (8.47%) on alcohol consumption. It implies that people covered by national health insurance are more likely to be drinkers in 2007, compared with the sample in 1993. This suggests that changes in smoking behavior were negatively significant, while alcohol consumption were positively significant in 2007 as compared to 1993. This *Year* is the only dummy variable that captured the different factors that changed during the period of 1993-2007. However, one should note that during the 14 year period time frame, many factors could also have changed, for example, government policies, laws and regulations, etc. In addition, it is also possible that changes in the price of alcohol or cigarette, as well as the effect of public health campaigns occurred during the 14 year time frame were being capture by the *Year* dummy variable, therefore, affecting the result.

Lastly, the marginal effects of the *interaction* term (*year* and *Insurance*) are positive but not significant. This implies a lack of evidence in my data for the effect of national health insurance on smoking and alcohol consumption over the period of 1993- 2007 (after the NHI reform). Therefore, I am NOT able to suggest any moral hazard effect from NHI reform based on my results[15]. This result implies that no moral hazard effect is found under Taiwan's NHI. I will further explore the reasons behind this finding (i.e. survey sample limitation) in the conclusion and discussion sections.

6.3.2 Public health insurance effect on other control variables

Besides the above three major explanatory variables, I also incorporated a set of variables reflecting on individuals' demographic, socioeconomic characteristics, self-reported health status, health indictors, health care utilization, and other variables in my study.

As shown in Table 6.6, for the smoking model, *Age, Gender, Married, Education level, HBP* (high blood pressure), *cancer*, *liver disease, Timespend* and *Healthcheck* are all negative and statistically significant. These are all consistent with my prediction. However, for the income level results, *Income03* (middle-high income group) *and Income04* (high income group), with *Income01* (low income group) as reference group, are statistically significant and negatively correlated with smoking. This is not consistent with my theoretical result. One possible reason is that higher income groups do more care about their health and change their preference (quit smoking) over 1993-2007. Health status did not show any significant effect on smoking. The three regional variables – *Northern, Central, Southern,* with *Eastern* as the reference group, are

[15] Difference –in-difference (DD) estimation is appropriate when the interventions are random, conditional on time and group fixed effects (Bertrand et al. 2004). Bertrand et al. (2004) argued that DD estimation has its limitations, such as serial correlation. Severe serial correlation problem can result in inconsistent estimators, leading to serious overestimate of t-statistic and significant level. Bertrand et al. (2004) have suggested that serial correlation might be the root cause for excessive false rejections of the null hypothesis of no significant effect.

all negative and statistically significant. This is also consistent with my prediction. The effects of medical service utilization – *inpatient services, outpatient services*, and *pharmacy visits* – on smoking have ambiguous effects according to my theoretical result. Empirically, the results show that *inpatient* and *outpatient* are both negative and statistically significant over 1993-2007. This might be a good evidence of doctor's indirect effect – doctor advice NHI enrollees to quit smoking. Conversely, this could be an evidence of the copayment mechanism of NHI in controlling part of patient's moral hazard, recall from section 4.2.2 result 11– copayment rate works to control for lifestyle behavior. Meanwhile, *pharmacy* is significant and positively correlated to smoking. This might be due to the fact that no copayments are associated with pharmacy visits.

For the alcohol consumption model, *Age, Gender, HBP* (high blood pressure), *Stroke* and *Timespend* are all negative and statistically significant. These are all consistent with my prediction. In addition, for the health status results, *Health03* (bad or worse health group), with *Healt01* (good or excellent health group) as reference group, is negative and statistically significant, which is consistent with my theoretical result. Education level does not show any significant effects. *Arthritis* has a positive and statistically significant effect on alcohol consumption. For medical service utilizations, *inpatient* and *outpatient services* have ambiguous effects in my theoretical model. In the empirical result, however, both of them are negative and statistically significant over 1993-2007. As mentioned in the previous section, this might exhibit doctor's indirect effect or copayment's effect. Lastly, the three regional variables – *Northern, Central, Southern,* with *Eastern* as the reference group – are all negative and statistically significant. This is also consistent with my prediction.

6.4 Summary of findings

Since the effect of national health insurance program on lifestyle behaviors was never fully explored in Taiwan, this chapter's empirical analyses contribute to the body of literature on health insurance. Two waves of Survey of Health and Living Status of the Middle- Age and Elderly (SHLS) of Taiwan (1993 and 2007) were used. Lifestyle behaviors (smoking and alcohol consumption) are employed as dependent variables. The independent variables include health status, health care utilization, demographic/socioeconomic and other control variables. Health status variables were self-reported as good, fair, and bad health condition. The demographic variables in the model are age (in years), gender, and marital status. Socioeconomic variables are annual total income and education level. Other controls include regional variables, travel time to hospital and regular checkups.

First, I introduce the univariate *Probit* model to measure the determinants of each unhealthy lifestyle behavior independently in 1993 and 2007. The smoking equations' results are not too dissimilar between the two data years. The difference is in medical service utilization variables – *inpatient* and *outpatient* services. They are negative and statistically significant in the 1993 model, but not significant in 2007. Also note that *timespend* variable is only negative and significant in 2007. As for the alcohol consumption models, the differences between the two years are income, education level, medical service utilization, regional variables, *timespend* and Health checkup. Income, education level, medical service utilization, *timespend* and *healthcheck* are statistically significant in the 2007 model only. On the other hand, the regional dummies are significant in the 1993 model only.

Secondly, I introduce the seemingly unrelated bivariate *Probit* model in order to capture the unobservable elements of smoking and alcohol consumption jointly. The results from the smoking equation are not too dissimilar to the alcohol consumption equation in 2007. *Age, Gender, Cancer,* and *timespend* are statistically significant in both of the smoking and alcohol consumption models. Income level, health status, and medical service utilization are statistically significant for the alcohol consumption model only, but married status and regional variables are significant for the smoking model. Lastly, there are some contradicting results for education level and *healthcheck* between the two models.

As for the 1993 models, results between smoking and alcohol consumption models differ in married status, education level, health status, medical service utilization, and Health checkup. Health status is statistically significant for the alcohol consumption model only, but married status, education level, medical service utilization and health checkup are significant for smoking model.

Lastly, in order to examine changes before and after the implementation of Taiwan's NHI over 1993 - 2007, I also employ a difference-in-difference model for smoking and alcohol consumption models by pooling the two data years together. The results show that *Insurance* status was negative but not significantly correlated with both the smoking and alcohol consumption equations; implying a lack of evidence for the moral hazard phenomenon in which people covered by public health insurance actually engage in more unhealthy behavior. However, the dummy variable *Year* is significantly and negatively correlated with smoking. This means those covered by national health insurance are less likely to smoke in 2007, compared to the sample in 1993. In contrast, *Year* is positive and statistically significant for alcohol consumption. This implies that those covered by national health insurance are more likely to drink in 2007, compared to the sample in 1993. Finally, the *interaction* term (*year* and *Insurance)* is positive but not significant, suggesting a lack of evidence for a moral hazard effect based on my sample. This also implies no moral hazard effect of lifestyle behavior change under Taiwan's National Health Insurance.

Table 6.1 Effects of National HealthInsurance on **Smoking** (Univariate Probit model)

Variable	Label (Expected Sign in Parentheses)	CHLS 2007(n=4478) Probit		CHLS 1993 (n=3124) Probit	
		Marginal effect	***Std. Error (Robust)***	***Marginal effect***	***Std. Error (Robust)***
Age	Age (-)	-0.00459	0.00053***	-0.01048	0.00154***
Gender	1= male (+)	0.31926	0.01161***	0.43509	0.15290***
Married	1= marital status (-)	-0.04247	0.01391***	-0.03392	0.01970*
Income 02	1=middle income (+)	-0.01369	0.01200	0.01368	0.02059
Income 03	1=middle –high income (+)	-0.00867	0.01441	-0.02859	0.02314
Income 04	1= high income (+)	-0.01995	0.01606	-0.07224	0.04114
Primary	1= primary school (-)	-0.01443	0.01354	-0.01409	0.01908
Diploma	1= junior/high school (-)	-0.05003	0.01342***	-0.10344	0.02155***
College	1= college or above (-)	-0.07865	0.01204***	-0.12928	0.02871***
Health 02	1= health status is fair (-)	0.02116	0.01140*	-0.11193	0.05947
Health 03	1= health status is bad or worse (-)	-0.00384	0.01356	-0.12928	0.02871
HBP	1=high blood pressure (-)	-0.02058	0.01017**	-0.06914	0.01760
Diabetes	1=diabetes (-)	-0.01167	0.01336	0.02958	0.03057
Stroke	1=stroke (-)	-0.01731	0.02065	-0.06821	0.02873**
Cancer	1=cancer (-)	-0.05966	0.01813**	-0.09511	0.05232
Liverdisease	1= liver disease (-)	-0.04922	0.01218***	-0.08290	0.02702
Arthritis	1= arthritis (-)	0.01714	0.01441	0.02028	0.02030
Inpatient	1=received inpatient service (+/-)	-0.02111	0.01321	-0.05130	0.02024**
Outpatient	1=received outpatient service (+/-)	-0.02218	0.01575	-0.06606	0.01925***
Pharmacy	1=received pharmacy service (+/-)	0.01056	0.01010	0.03372	0.01673**
Northern	1= in northern area of Taiwan (-)	-0.07001	0.02283***	-0.11173	0.03537
Central	1= in central area of Taiwan (-)	-0.07673	0.02311***	-0.15878	0.03417
Southern	1= in southern area of Taiwan (-)	-0.07951	0.02279***	-0.15388	0.03362***
Timespend	In minutes (-)	-0.00061	0.00030**	-0.00024	0.00019
Healthcheck	1=received health checking (-)	-0.02067	0.00958**	-0.03800	0.01765**
Pseudo R2		0.2362		0.2434	
Prob>chi2		0.0000		0.0000	
Log pseudolikelihood		-1599.4685		-1422.6565	

*** significant at the 0.01 level; ** significant at the 0.05 level; *significant at the 0.10 level.

Table 6.2 Effects of NHI on **Alcohol consumption** (Univariate Probit model)

Variable	Label (Expected Sign in Parentheses)	CHLS 2007(n=4478) Probit		CHLS 1993 (n=3124) Probit	
		Marginal effect	***Std. Error (Robust)***	***Marginal effect***	***Std. Error (Robust)***
Age	Age (-)	-0.00637	0.00077***	-0.00507	0.00114***
Gender	1= male (+)	0.29228	0.01434***	0.22567	0.01351***
Married	1= marital status (-)	-0.02131	0.01799	-0.00029	0.01426
Income 02	1=middle income (+)	0.02590	0.01818	-0.00071	0.01503
Income 03	1=middle –high income (+)	0.03711	0.02305*	0.03305	0.01861*
Income 04	1= high income (+)	0.07790	0.02889***	0.01784	0.03861
Primary	1= primary school (-)	0.06216	0.02003***	0.02025	0.01492
Diploma	1= junior/high school (-)	0.09121	0.02440***	0.01084	0.02001
College	1= college or above (-)	0.08549	0.04139**	0.00392	0.03450
Health 02	1= health status is fair (-)	-0.03537	0.01552**	-0.00790	0.01344
Health 03	1= health status is bad or worse (-)	-0.10284	0.01805**	-0.04788	0.01539
HBP	1=high blood pressure (-)	0.00697	0.01500	-0.02892	0.01327 **
Diabetes	1=diabetes (-)	-0.01456	0.01941	-0.02628	0.01985
Stroke	1=stroke (-)	-0.10904	0.02476***	-0.08057	0.01627***
Cancer	1=cancer (-)	-0.08116	0.03162**	-0.01178	0.04453
Lungdisease	1= lung disease (-)	0.04148	0.02490*	-0.01877	0.01596
Arthritis	1= arthritis (-)	0.03624	0.01962*	0.02715	0.01543*
Inpatient	1=received inpatient service (+/-)	-0.06271	0.01871***	-0.02924	0.01510*
Outpatient	1=received outpatient service (+/-)	-0.03890	0.02367*	-0.01947	0.01382
Pharmacy	1=received pharmacy service (+/-)	0.05779	0.01477***	0.00543	0.01225
Northern	1= in northern area of Taiwan (-)	-0.01870	0.04334	-0.08350	0.02259***
Central	1= in central area of Taiwan (-)	-0.07881	0.04097*	-0.08809	0.02324***
Southern	1= in southern area of Taiwan (-)	-0.03898	0.04253	-0.10226	0.02187
Timespend	In minutes (-)	-0.00077	0.00038**	-0.00023	0.00015
Healthcheck	1=received health checking (-)	0.04464	0.01376***	-0.01344	0.01311
Pseudo R2		0.1823		0.1726	
Prob>chi2		0.0000		0.0000	
Log pseudolikelihood		-2200.1001		-1207.8896	

*** significant at the 0.01 level; ** significant at the 0.05 level; *significant at the 0.10 level.

Table 6.3 testing for unobserved exogeneity: $H_0: \rho = 0$; $H_a: \rho \neq 0$

		Bivariate Probit Model for Smoking and Alcohol Consumption		
Year	ρ	***Z -stat***	***LR test***	***Wald test***
1993	0.3518	9.11***	86.16***	82.92***
2007	0.2592	7.74***	61.41***	59.91***

*** *p < 0.01*; ** *p < 0.05 ; * p < 0.10.*

Table 6.4 Effects of NHI for Bivariate Probit model in 2007 (n=4478)

Variable	Label (Expected Sign in Parentheses)	Dependent variable: Smoking		Alcohol consumption	
		Coefficient	***Std. Error (Rob.)***	***Coefficient***	***Std. Error (Rob.)***
Intercept		0.6800	0.2577 ***	0.3574	0.2337
Age	Age (-)	-0.0242	0.0028 ***	-0.0201	0.0025 ***
Gender	1= male (+)	1.6399	0.0662 ***	0.9513	0.0497 ***
Married	1= marital status (-)	-0.2113	0.0661 ***	-0.0650	0.0563
Income 02	1=middle income (+)	-0.0722	0.0660	0.0817	0.0574
Income 03	1=middle –high income (+)	-0.0444	0.0804	0.1162	0.0704 *
Income 04	1= high income (+)	-0.1042	0.0955	0.2353	0.0833 ***
Primary	1= primary school (-)	-0.0658	0.0736	0.1981	0.0629 ***
Diploma	1= junior/high school (-)	-0.2846	0.0853 ***	0.2829	0.0721 ***
College	1= college or above (-)	-0.5767	0.1367 ***	0.2520	0.1155 **
Health 02	1= health status is fair (-)	0.1116	0.0593 *	-0.1148	0.0507 **
Health 03	1= health status is bad or worse (-)	-0.0230	0.0735	-0.3482	0.0653 ***
HBP	1=high blood pressure (-)	-0.1213	0.0559 **	0.0189	0.0479
Diabetes	1=diabetes (-)	-0.0602	0.0761	-0.0446	0.0635
Stroke	1=stroke (-)	-0.0941	0.1240	-0.4014	0.1085 ***
Cancer	1=cancer (-)	-0.4166	0.1664 **	-0.2867	0.1260 **
Liverdisease	1= liver disease (-)	-0.3052	0.0900 ***	-	-
Lungdisease	1= lung disease (-)	-	-	0.1156	0.0739
Arthritis	1= arthritis (-)	0.0969	0.0719	0.1196	0.0599 **
Inpatient	1=received inpatient service (+/-)	-0.1157	0.0786	-0.2098	0.0666 ***
Outpatient	1=received outpatient service (+/-)	-0.1226	0.0755	-0.1179	0.0711 *
Pharmacy	1=received pharmacy service (+/-)	0.0600	0.0530	0.1842	0.0455 ***
Northern	1= in northern area of Taiwan (-)	-0.4248	0.1461 ***	-0.0625	0.1394
Central	1= in central area of Taiwan (-)	-0.4838	0.1442 ***	-0.2611	0.1384 *
Southern	1= in southern area of Taiwan (-)	-0.4743	0.1447 ***	-0.1301	0.1390
Timespend	In minutes (-)	-0.0032	0.0016 **	-0.0024	0.0012 **
Healthcheck	1=received health checking (-)	-0.1160	0.0511 **	0.1422	0.0443 ***
Log pseudolikelihood			-3768.8587		
Rho (ρ)			0.2592		
Wald test			59.90		

*** significant at the 0.01 level; ** significant at the 0.05 level; *significant at the 0.10 level.

Table 6.5 Effects on lifestyle behavior for Bivariate Probit model in 1993 (n=3124)

Variable	Label (Expected Sign in Parentheses)	Dependent variable			
		Smoking		Alcohol consumption	
		Coefficient	***Std. Error (Rob.)***	***Coefficient***	***Std. Error (Rob.)***
Intercept		1.7989	0.4115 ***	0.5916	0.4412
Age	Age (-)	-0.0352	0.0052 ***	-0.0238	0.0056 ***
Gender	1= male (+)	1.6479	0.0730 ***	1.1858	0.0800 ***
Married	1= marital status (-)	-0.1157	0.0642 **	-0.0099	0.0696
Income 02	1=middle income (+)	0.0456	0.0680	-0.0002	0.0738
Income 03	1=middle –high income (+)	-0.1042	0.0824	0.1590	0.0812 **
Income 04	1= high income (+)	-0.2595	0.1719	0.1019	0.1691
Primary	1= primary school (-)	-0.0436	0.0648	0.0960	0.0704
Diploma	1= junior/high school (-)	-0.3887	0.0940 ***	0.0530	0.0933
College	1= college or above (-)	-0.5377	0.1623 ***	0.0132	0.1662
Health 02	1= health status is fair (-)	-0.0461	0.0627	-0.0385	0.0670
Health 03	1= health status is bad or worse (-)	-0.0463	0.0782	-0.2486	0.0902 ***
HBP	1=high blood pressure (-)	-0.2472	0.0645 ***	-0.1498	0.0692 **
Diabetes	1=diabetes (-)	0.0719	0.0985	-0.1368	0.1110
Stroke	1=stroke (-)	-0.2551	0.1174 **	-0.5284	0.1453 ***
Cancer	1=cancer (-)	-0.4024	0.2536	-0.0626	0.2325
Liverdisease	1= liver disease (-)	-0.3007	0.1124 ***	-	-
Lungdisease	1= lung disease (-)	-	-	-0.1252	0.0831
Arthritis	1= arthritis (-)	0.0643	0.0665	0.1350	0.0705 *
Inpatient	1=received inpatient service (+/-)	-0.1819	0.0755 **	-0.1498	0.0827 *
Outpatient	1=received outpatient service (+/-)	-0.2108	0.0610 ***	-0.0922	0.0650
Pharmacy	1=received pharmacy service (+/-)	0.1136	0.0554 **	0.0287	0.0597
Northern	1= in northern area of Taiwan (-)	-0.4011	0.1348 ***	-0.4599	0.1327 ***
Central	1= in central area of Taiwan (-)	-0.5797	0.1344 ***	-0.4886	0.1324 ***
Southern	1= in southern area of Taiwan (-)	-0.5652	0.1355 ***	-0.5711	0.1330 ***
Timespend	In minutes (-)	-0.0008	0.0006	-0.0012	0.0007
Healthcheck	1=received health checking (-)	-0.1299	0.0619 **	-0.0574	0.0658
Log pseudolikelihood			-2587.4668		
Rho (ρ)			0.3518		
Wald test			82.92		

*** significant at the 0.01 level; ** significant at the 0.05 level; *significant at the 0.10 level.

Table 6.6 Difference- in-Difference model for lifestyle behaviors – *Pooled Probit model* (n=4361)

Variable	Label (Expected Sign in Parentheses)	Dependent variable: Smoking		Dependent variable: Alcohol consumption	
		Marginal Eff.	***Std. Error(Rob.)***	***Marginal Eff.***	***Std. Error(Rob.)***
Insurance	NHI status (+)	-0.0021	0.0166	-0.0100	0.0153
Year	Year dummy after reform; 1=2007	-0.0738	0.0341 **	0.0847	0.0355 ***
Interaction	Interaction between Insur. and Year	0.0473	0.0445	0.0350	0.0324
Age	Age (-)	-0.0090	0.0012 ***	-0.0056	0.0010 ***
Gender	1= male (+)	0.3436	0.0121 ***	0.2143	0.0112 ***
Married	1= marital status (-)	-0.0398	0.0144 ***	0.0060	0.0118
Income 02	1=middle income (+)	0.0048	0.0146	-0.0028	0.0123
Income 03	1=middle –high income (+)	-0.0412	0.0157 **	0.0394	0.0162 ***
Income 04	1= high income (+)	-0.0825	0.0242 ***	0.0143	0.0317
Primary	1= primary school (-)	-0.0048	0.0133	0.0092	0.0118
Diploma	1= junior/high school (-)	-0.0396	0.0162 **	-0.0416	0.0141
College	1= college or above (-)	-0.0679	0.0250 **	-0.0189	0.0250
Health 02	1= health status is fair (-)	-0.0030	0.0139	-0.0179	0.0115
Health 03	1= health status is bad or worse (-)	0.0045	0.0167	-0.0642	0.0127 ***
HBP	1=high blood pressure (-)	-0.0601	0.0128 ***	-0.0214	0.0112 **
Diabetes	1=diabetes (-)	0.0098	0.0215	-0.0257	0.0159
Stroke	1=stroke (-)	-0.0318	0.0224	-0.0798	0.0137 ***
Cancer	1=cancer (-)	-0.0793	0.0301 **	-0.0012	0.0319
Liverdisease	1= liver disease (-)	-0.0697	0.0188 ***	-	-
Lungdisease	1= lung disease (-)	-	-	-0.0078	0.0140
Arthritis	1= arthritis (-)	0.0198	0.0151	0.0285	0.0132 **
Inpatient	1=received inpatient service (+/-)	-0.0498	0.0143 ***	-0.0322	0.0124 **
Outpatient	1=received outpatient service (+/-)	-0.0530	0.0158 ***	-0.0261	0.0136 **
Pharmacy	1=received pharmacy service (+/-)	0.0212	0.0125 *	0.0030	0.0106
Northern	1= in northern area of Taiwan (-)	-0.1152	0.0245 ***	-0.0707	0.0204 ***
Central	1= in central area of Taiwan (-)	-0.1441	0.0239 ***	-0.0946	0.0198 ***
Southern	1= in southern area of Taiwan (-)	-0.1416	0.0231 ***	-0.0985	0.0190 ***
Timespend	In minutes (-)	-0.00026	0.00016 *	-0.00029	0.00015 **
Healthcheck	1=received health checking (-)	-0.0216	0.0129 **	0.0011	0.0111
Log pseudolikelihood		-1809.59		-1687.06	
Pseudo R-squared		0.2446		0.1637	
Wald Chi -Squared		776.56		540.09	

*** significant at the 0.01 level; ** significant at the 0.05 level; *significant at the 0.10 level.

Chapter 7 Conclusion and Discussion

7.1 Conclusion

This dissertation made several contributions to the theoretical and empirical literature on lifestyle behaviors. First, I modify and build a national health insurance theoretical model with three government policy parameters in order to discuss the determinants on lifestyle behaviors. Then, I investigate empirically using Taiwan's survey data to assess lifestyle behavior changes under Taiwan's national health insurance reform. My research focuses on examining the determinants of lifestyle behaviors under the national health insurance and on comparing lifestyle behavior changes before and after the reform. Most previous researches in Taiwan on the determinants of lifestyle behaviors and/or medical service were only descriptive in nature. Most theoretical studies in other countries focused only on medical service utilization under private health insurance markets.

In the analytical section, I modify and build a "behavioral moral hazard" theoretical model proposed by Ehrlich and Becker (1972) and Stanciole (2007) and apply to Taiwan's national health insurance setting. I derive the determinants of demand for medical service and lifestyle behavior under universal health insurance. Moreover, I also examine how three government policy parameters – patient's copayment rate, premium, and payroll tax rate – affect a typical individual's well-being or social welfare given individual's lifestyle under Taiwan's NHI system.

I apply the Stackelberg two-stage individual's decision making model concept into my theoretical moral hazard model. In stage one, an individual moves first and decides his / her optimal unhealthy behavior (β^*) before knowing the actual health status. In stage two, once the health status is revealed, he / she will move to decide the optimal amount of medical care (m^*) given their optimal unhealthy behavior (β^*). By applying the backward induction method, I show that after individuals falling sick in stage two, the optimal demand for medical service decreases when faced with a higher payroll tax rate, a higher copayment rate, a higher premium, and a higher medical service price. However, an individual's optimal demand for medical service increases with the individual's income level, poor health status and with the addiction of unhealthy behavior. In stage one, the individual's optimal unhealthy behaviors decrease with a higher copayment rate, a higher payroll tax rate, a higher premium, a higher medical price and with poor health status; but increase with income level. The effect from medical service is ambiguous.

In order to discuss the effects of the three government policy parameters (copayment rate, premium, and payroll tax rate), my model assumes the extension of a social planner whose objective is to maximize the representative individual's well-being or social welfare. I assume that all individuals are homogenous and the social planner is the Taiwanese government. My model results suggest that the copayment rate changes the individual's well-being under certain circumstances. If the decreasing in medical spending for patients is at a rate greater than the combined negative effects from decreasing the premium (R), payroll tax rate (*t*) reduction and medical spending through decreasing unhealthy behavior, individual's welfare will decrease, i.e., $\frac{\partial EU}{\partial c} < 0$. On the other hand, if the first term is smaller than the last three terms, an increase in the copayment rate will increase the individual's welfare, $i.e., \frac{\partial EU}{\partial c} > 0$

Lastly, following the same analogy, payroll tax rate has a positive effect on the individual's well-being. This implies that when the government imposes a payroll tax, an individual will expect to pay more for healthcare cost. However, an individual also could gain more social welfare not only from the positive direct effect of decreasing medical spending, but also from the positive indirect effect from government payroll tax reduction due to the decrease in unhealthy behavior. In addition, premium also has a positive effect on the individual's well-being. This implies that when the government imposes a higher premium, an individual will expect to pay more for healthcare cost. However, an individual also could gain more social welfare not only from the positive direct effect of decreasing medical spending, but also from the positive indirect effect from government premium reduction due to a decrease in unhealthy behavior.

In my empirical investigation, I use two waves of the Health and Living Status of the Middle- Age and Elderly (SHLS) survey in Taiwan (1993 and 2007). Lifestyle behaviors (smoking and alcohol consumption) are employed as dependent variables. The independent variables include health status, health care utilization, demographic/socioeconomic and other control variables. Health status variables are self-reported as good, fair, and bad health condition. The demographic variables in the model are age (in years), gender, and marital status. Socioeconomic variables are annual total income and education level. Other controls include regional variables, travel time to hospital and regular checkups.

First, I introduce the univariate *Probit* model to measure the determinants of each unhealthy lifestyle behavior independently in 1993 and 2007. The smoking equation results are not too dissimilar between the two data years. The difference is in the two medical service utilization variables – *inpatient* and *outpatient services*. As for the alcohol consumption models, the differences between the two years are *income*, *education level*, *medical service utilization*, *regional* variables, *timespend* and *healthcheck*. Note that *healthcheck* is expected to have a negative impact on alcohol consumption. Nevertheless, in the 2007 model, *healthcheck* is found to be positive and statistically significant. This implies that people who had a health checkup during the previous year are more likely to consume alcohol. This empirical result seemingly goes against most common logic. However, additional insights can be gained upon further examination on the survey questionnaire itself, specifically regarding the alcohol consumption question. Recall that in section 5-2, the questionnaire elicited respondents' drinking status in a dichotomous format (drinker=1, nondrinker=0). This implicitly placed those who drink a six-pack per day with those who drink one glass of red wine occasionally in the same category. It is clear that this posed potential issue when one aims to associate drinking with health status. There exist ample researches that provide evidence for the positive health benefit from drinking wine (Kenkel, 1995). In general, moderate alcohol consumption seemed to be a positive input in the health production function (or beneficial health input).

Next, I introduce the seemingly unrelated bivariate *Probit* model in order to capture the unobservable elements of smoking and alcohol consumption jointly. The results from the smoking equation are not too dissimilar to the alcohol consumption equation in 2007. In the 1993 models, results between the smoking and alcohol consumption models differ in marital status, education level, health status, medical service utilization, and health checkup.

Moreover, I notice a significant correlation in the residuals in the smoking and alcohol consumption models for 2007 and 1993. I find that the unobservable determinants of the two models are positively correlated. Stanciole (2007) suggests that the positive association between unobservable factors of the two models may demonstrate some degree of complementarity.

Lastly, in order to examine changes before and after the implementation of Taiwan's NHI over 1993-2007, I introduce a difference-in-difference model for smoking and alcohol consumption by pooling the two data years together. The results suggest a lack of evidence for moral hazard based on my data. Previous studies discuss that health insurance does have an incentive effect in terms of ax-ante moral hazard and do find significant impacts on lifestyle choice (Courabge and de Coulon, 2004; Stanciole, 2007; and Preux, 2010). There are few possible reasons for the lack of evidence for moral hazard, especially in smoking and alcohol consumption under Taiwan's NHI. First, the effect of national health insurance on smoking and alcohol consumption increases over 1995–2007, this is due to demand management introduced by NHI reform in order to control individual's medical service demand. Consequently, this had affected individuals' lifestyle choices[16]. In addition, public health campaigns, new laws and regulations and other government policy changes during the same period, could have also affected individuals' lifestyle choices, Banning of smoking in public places[17], a health and welfare tax on cigarette[18], and drunk driving law[19] are some examples. Another possibility for lack of "moral hazard" result is that it is overshadowed by a variety of other effects that I don't capture in my model because of lack of data. Once could add additional dummy variables that could have changed during the period of 1993 and 2007 to check whether the regression results would change or not.

7.2 Discussion and policy implication

The contributions of my dissertation have several policy implications. First of all, the theoretical implication of the effects on medical service demand given optimal lifestyle behaviors (in stage two) show that the demand for medical services decrease with copayment rate, payroll tax rate, premium, medical service price. These government policy parameters might serve as effective tools in controling or reducing the moral hazard problem.

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[16] A new co-payment policy raises co-payment fees for ambulatory visits at hospitals was implemented on July 15, 2005.
[17] A anti-smoking law went into effect in Taiwan on July 11, 2007, banning smoking in indoor places including schools, hotels, restaurants and all public transport facilities.
[18] It took effect in Feb 2006, the Taiwanese government passed a law to increase the Health and Welfare Tax from NT$5 per pack to NT$10 per pack. The tax is added directly at the time of purchase.
[19]Alcohol and legal implications of drunk driving - Road Traffic Act 93/96 has been in effect since March 1998. Sections 122, 126, 149

Secondly, another theoretical implication regards the effects on lifestyle behavior – smoking and alcohol consumption (in stage one). My model suggests that unhealthy lifestyle behaviors decrease with copayment rate, payroll tax rate, premium and medical service price. This also implies that the Taiwanese government could control and reduce total medical care spending not only through demand management, but also through promoting healthy lifestyle behaviors, This is intuitive since individuals have an incentive to reduce their preventative efforts once they are covered by medical insurance (or Medicare) as shown in Klick and Stratman (2004), Stanciole (2007), and Preux (2010).

However, unhealthy lifestyle behaviors are found to have an ambiguous effect on medical service demand. This interesting yet important theoretical finding is consistent with Dave and Kaestner's (2006) finding, that – health insurance (physician contact) has an ambiguous effect on prevention behaviors. They show that doctors' visit has an ambiguous effect on prevention, depending on whether the person is healthier or sicker than expected.

Thirdly, my empirical findings suggest that the univariate standard probit model and single period estimates omit significant variables that are intended to capture individual's unobservable heterogeneity. My results have shown that the error terms from both of the lifestyle choice equations are likely to be correlated over time. Since unobservable factors may affect both the propensity to smoke and to drink, a single period model's results will be biased. Therefore, the standard Probit model (ignoring the unobservable individual heterogeneity) would also lead to biased result. I use an alternative approach – the seemingly unrelated bivariate Probit model – to control for individual's unobservable heterogeneity. This model takes two independent binary probit models into account and estimates them jointly. By applying the seemingly unrelated bivariate Probit model, I find that the unobservable determinants of the two models are positively correlated. As per Stanciole (2007), the positive association between smoking and alcohol consumption may suggest complementarity.

Fourth, one of my empirical findings – negative and significant effects of demands for medical care such as inpatient and outpatient services for alcohol consumption in the 2007 model are similar to Dave and Kaestner's (2006) results in that physician visits have an indirect effect in terms of triggering a significant reduction in alcohol consumption among Medicare recipients.

Lastly, attention should be paid to the data limitation issue. Incomplete data limit credible interpretation for some of my results. For example, interpretation of the government policy parameters (individual's payroll tax rate, copayment rate and premium) was not straightforward. Furthermore, my empirical results are not generalizable to the whole population in Taiwan because the survey data excluded the younger demographics (i.e., aged 20 - 50).

7.3 Future Research

There are two main possible future research extensions from this dissertation that I have identified.

First, I only discussed the individual's lifestyle and medical service behavior for moral hazard in my research. Exploring health care providers' behavior both analytically and empirically would be an important extension. I will focus on the supply side of health care – namely physicians' behavior and hospital's management system. I would define a representative physician's utility function embedded with his / her profit function. Assumptions associated with the physician's utility function would consider the price and input cost of medical services, which may also be controlled by the government. Or another possible approach to look at provider's behavior is from doctor's role. Ideally, the doctor's role in the supply of medical service should have been incorporated into the model. In this case, the government could use the three instruments (copayment rate, payroll tax rate, and premium) of balanced-budget constraint in the management of Taiwan's national health insurance program by controlling doctor's moral hazard. For example, in term of doctor's profit incentive, the government could decide to pay doctors or hospitals only a certain percentage of balanced budgets, instead of total amount of balanced budgets[20], to gage doctor or hospitals' respond in order to investigate doctor's moral hazard. Then, by discussing the individual's well-being and social welfare, I could examine the effects of the three government policy instruments on the well-being function. However, the lack of data prohibited me from including doctor's moral hazard in the model.

Furthermore, since the government balanced- budget constraint in my model is a very simplified assumption. I could also expand and relax my assumptions by including other possible financing sources such as excise tax on cigarette and alcohol consumption, or general income tax in order to introduce some realism in my government balanced- budget constraint.

Empirically, the lack of data (i.e. variables in government healthcare budget or in physician's profit function) on health care providers in Taiwan's SHLS posed a major hurdle. It is the reason that my research thus far has excluded the investigation regarding health care providers' behavior. Nevertheless, this topic shall be explored in my future research.

Second, private health insurance could also be considered both theoretically and empirically. In Taiwan, the private health insurance market has been growing substantially in recent years. Investigating the effects of both private and public health insurance system on lifestyle behaviors would be an interesting future endeavor. However, the needed data on private insurance has been limited in the SHLS survey. A previous study in the United Kingdom (Courbage and Coulon,

[20] In Chapter 4, equation (5) on page 49, I assume a simplified assumption that the government makes its budget balance by paying total budget (100%) for individuals' total copayment expense.

2004) had shown the effect of health insurance on prevention under a mixed public and private health insurance system. They have found that purchasing private health insurance could have modified the probability of individual's prevention behavior (smoking, regular checkup and exercise). Private health insurances allow individuals to choose a subset of treatment plan that they receive in the UK's National Health Service and to supplement the overall level of health insurance plan they receive. Further modifications to my theoretical and empirical models will be needed in order to incorporate private health insurance to my future research.

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Appendix 1

Form the total differentiation of equation (6) below, we can find:

$$P(\beta^*)\{[(-cp_m - L'_m(m,\beta)U'(Y - tY - cp_m m - R - L(m,\beta^*)] + D[S\ (\beta^*), m, \beta^*]\}$$

Taking derivative with respect to S: $P(\beta^*)[\ D''_{ms}(.)]dS$

Taking derivative with respect to *m*: $P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}\ \mathrm{d}m$

Taking derivative with respect to Y: $-P(\beta^*)[(1-\mathrm{t})(cp_m + L'_m)U''(.)]dY$

Taking derivative with respect to (1-t): $-P(\beta^*)[Y(cp_m + L'_m)U''(.)]d(1-t)$

Taking derivative with respect to c: $-P(\beta^*)[p_m * U'(.) - mp_m(cp_m + L'_m)U''(.)]dc$

Taking derivative with respect to p_m: $-P(\beta^*)[c * U'(.) - mc(cp_m + L'_m)U''(.)]dp_m$

Taking derivative with respect to R: $P(\beta^*)[(cp_m + L'_m)U''(.)]dR$

Taking derivative respect with β: $-\{P(\beta^*)\{L''_{m\beta}\ [\mathrm{U}''(.) - \mathrm{U}'(.)] + L'_\beta cp_m \mathrm{U}''(.) - [D''_{mS}\ (.)S'_\beta]\} - P'(\beta^*)[(cp_m + L'_m)U'(.) + D'_m(.)]\ \}d\beta$

Then, total differentiating with respect to all parameters (*m*, S, Y, (1-t), p_m, c, R)

$$P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}\ \mathrm{d}m$$

$$- P(\beta^*)[(1-\mathrm{t})(cp_m + L'_m)U''(.)]dY - P(\beta^*)[Y(cp_m + L'_m)U''(.)]d(1-t)$$

$$+ P(\beta^*)[\ D''_{ms}(.)]dS - P(\beta^*)[p_m * U'(.) - mp_m(cp_m + L'_m)U''(.)]dc$$

$$- P(\beta^*)[c * U'(.) - mc(cp_m + L'_m)U''(.)]dp_m + P(\beta^*)[(cp_m + L'_m)U''(.)]dR$$

$$- \{P(\beta^*)\{L''_{m\beta}\ [\mathrm{U}''(.) - \mathrm{U}'(.)] + L'_\beta cp_m \mathrm{U}''(.) - D''_{mS}\ (.)S'_\beta]\}$$

$$- P'(\beta^*)[(cp_m + L'_m)U'(.) + D'_m(.)]\ \}d\beta$$

Rearrange again:

$P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}\, \mathrm{d}m = P(\beta^*)[(1 - \mathrm{t})(cp_m + L'_m)U''(.)]dY + P(\beta^*)[Y(cp_m + L'_m)U''(.)]d(1-t) - P(\beta^*)[\, D''_{ms}(.)]dS + P(\beta^*)[p_m * U'(.) - mp_m(cp_m + L'_m)U''(.)]dc + P(\beta^*)[c * U'(.) - mc(cp_m + L'_m)U''(.)]dp_m - P(\beta^*)[(cp_m + L'_m)U''(.)]dR + P(\beta^*)\{L''_{m\beta}\, [\mathrm{U}''(.) - \mathrm{U}'(.)] + L'_\beta cp_m \mathrm{U}''(.) - D''_{mS}\,(.)S'_\beta]\} - P'(\beta^*)[(cp_m \; + L'_m)U'(.) + \; D'_m(.)]\, \}d\beta$

Then:

$$dm = \frac{P(\beta^*)[(1-\mathrm{t})(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}}\, dY +$$

$$\frac{P(\beta^*)[Y(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} d(1-t) +$$

$$\frac{P(\beta^*)[p_m * U'(.) - mp_m(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} dc +$$

$$\frac{P(\beta^*)[c * U'(.) - mc(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} dp_m -$$

$$\frac{P(\beta^*)[(cp_m + L'_m)U''(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} dR -$$

$$\frac{P(\beta^*)[\, D''_{ms}(.)]}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} dS +$$

$$\frac{P(\beta^*)\{L''_{m\beta}\, [\mathrm{U}''(.) - \mathrm{U}'(.)] + L'_\beta cp_m \mathrm{U}''(.) - D''_{mS}\,(.)S'_\beta]\} - P'(\beta^*)[(cp_m + L'_m)U'(.) + D'_m(.)]\, \}}{P(\beta^*)\{[(cp_m)^2 + 2cp_m L'_m)U''(.) + L''_m U''(.) - L''_m U'(.)] + D''_m(.)\}} d\beta$$

Appendix 2

$$\underset{\beta}{Max} \quad EU(\beta) = P(\beta)\{U[(Y - tY - cp_m m^* - R - L(m^*, \beta)] + D[S\,(\beta), m^*,]\} +$$

$$(1 - P(\beta))U[Y - tY - R - L(\beta)\,] + U(\beta)$$

$$= P\,(\beta)\mathrm{U}_1 + [1 - P\,(\beta)]\mathrm{U}_2 + U(\beta) \qquad (4)$$

subject to $x + cp_m m \;+\; R + tY +\; L(m^*, \beta) = Y$

where $U^{sick} = U_1 = U[(Y - tY - cp_m m^* - R - L(m^*, \beta)] + D[S\,(\beta), m^*, \beta]$, and

$U^{Health} = U_2 = U\big(Y - tY - R - L(\beta)\big)$ with $U_1 < U_2$

F.O.C

$$P'(\beta)[\mathrm{U\ (sick)}] + P(\beta)\{[-L'_\beta\, U'_{(sick)} + [D'_S\, S'_\beta]U'_{(sick)}\} - P'(\beta)[\mathrm{U\ (health)}] + [1 - P(\beta)](-L'_\beta\,)U'_{(health)} + U'(\beta) = 0$$

Arranging :

$$U'(\beta) = P'(\beta)[U_2(.) - U_1(.)] + P(\beta)\big[L'_\beta U_1(.)\big] - P(\beta)[D'_S\, S'_\beta]U'_{(sick)} + [1 - P(\beta)]\big(L'_\beta\,\big)U'_2(.) \qquad (9)$$

Second Order Condition,

$$\begin{aligned}\frac{\partial^2 EU}{\partial \beta^2} = {} & P''(\beta)[\mathrm{U\ (sick)}] + P'(\beta)\{\big[-L'_\beta\, U'_{(sick)} + D'_S\, S'_\beta U'_{(sick)}\big\} \\ & + P'(\beta)\big\{\big[-L'_\beta\, U'_{(sick)} + D'_S\, S'_\beta U'_{(sick)}\big\} \\ & + P(\beta)\big\{-L''_{\beta\beta}\, U'_{(sick)} + L''_{\beta\beta}\, U''_{(sick)} + D'_S\, S'_\beta U''_{(sick)} - L'_\beta\, U''_{(sick)}\, D'_S\, S'_\beta \\ & + [(D''_{SS}\, S'_\beta\big) - D'_S S''_{\beta\beta}]U'_{(sick)}\big\} - \big\{P''(\beta)[\mathrm{U\ (health)}] + P'(\beta)\big(-L'_\beta\big)U'_{(health)}\big\} \\ & - P'(\beta)\big(-L'_\beta\big)U'_{(health)} + [1 - P(\beta)]\big[\big(-L''_{\beta\beta}\big)U'_{(health)} + L''_{\beta\beta} U''_{(health)}\big] \\ & + U''(\beta)\end{aligned}$$

Rearranging:

$$\frac{\partial^2 EU}{\partial \beta^2} = P''(\beta)[\mathrm{U}\ (1)] + P'(\beta)\{[-L'_\beta\ U'_{(1)} + D'_S\ S'_\beta U'_{(1)}\}$$

$$+ P'(\beta)\{[-L'_\beta\ U'_{(1)} + D'_S\ S'_\beta U'_{(1)}\}$$

$$+\ P(\beta)\{\ -L''_{\beta\beta}\ U'_{(1)} + L''_{\beta\beta}\ U''_{(1)}\ + D'_S\ S'_\beta U''_{(1)}\ - L'_\beta\ U''_{(1)}\, D'_S\ S'_\beta + [(D''_{SS}\ S'_\beta)$$

$$-\ D'_S S''_{\beta\beta}]U'_{(1)}\} - \{P''(\beta)[\mathrm{U}\ (2)] + P'(\beta)(-L'_\beta)U'_{(2)}\} - P'(\beta)(-L'_\beta)U'_{(2)}$$

$$+ [1 - P(\beta)][(-L''_{\beta\beta})U'_{(2)} + L''_{\beta\beta}U''_{(2)}] + U''(\beta)$$

Therefore , the S.O.C is satisfied for maximum optimization :

$$\frac{\partial^2 EU}{\partial \beta^2} = P''(\beta)[\mathrm{U}_1 - \mathrm{U}_2\ ] + 2P'(\beta)U'_1\{[-L'_\beta - D'_S\ S'_\beta]\} + P(\beta)\{[L''_{\beta\beta}\ (U''_1 - U'_1)] +$$

$$U''_1\,(D'_S\ S'_\beta)(D'_S\ S'_\beta - L'_\beta) + [(D''_{SS}\ S'_\beta) + D'_S S''_{\beta\beta}]U'_1\} +$$

$$[1 - P(\beta)][(-L''_{\beta\beta})U'_2 + L''_{\beta\beta}U''_2] + U''(\beta) < 0 \qquad (10)$$

Appendix 3

From First Order Condition with respect to β in equation (9), we get the following result:

$$P'(\beta)[U_1] + P(\beta)\{[-L'_\beta\, U'_1 - [D'_S\, S'_\beta]U'_1\} - P'(\beta)[U_2] + [1 - P(\beta)](-L'_\beta\,)U'_2 + U'(\beta)$$

Total differentiate with respect to all parameters:

$$\{P''(\beta)[U_1 - U_2\,]$$

$$+\,2P'(\beta)U'_1\{[-L'_\beta - D'_S\, S'_\beta]\}$$

$$+\,P(\beta)\{[L''_{\beta\beta}\,(U''_1 - U'_1)] + U''_1\,(D'_S\, S'_\beta)(D'_S\, S'_\beta - L'_\beta) + [(D''_{SS}\, S'_\beta) + D'_S S''_{\beta\beta}]U'_1\}$$

$$+\,[1 - P(\beta)][(-L''_{\beta\beta})U'_2 + L''_{\beta\beta}U''_2] + U''(\beta)\}d\beta + \{P'(\beta)[(1-t)U'_1]$$

$$-\,P(\beta)(1-t)L'_\beta U''_1 + P'(\beta)[(1-t)U'_2] + P(\beta)(D'_S\, S'_\beta)(1-t)U''_1$$

$$-\,[1 - P(\beta)](1-t)L'_\beta U''_2\,\}dY + \{P'(\beta)[YU'_1] - P(\beta)YL'_\beta U''_1 + P'(\beta)[YU'_2]$$

$$+\,P(\beta)(D'_S\, S'_\beta)(Y)U''_1 - [1 - P(\beta)]YL'_\beta U''_2\,\}d(1-t) + \{P'(\beta)[(-cm)U'_1]$$

$$+\,P(\beta)(D'_S\, S'_\beta)(-cm)U''_1 - P(\beta)(-cm)L'_\beta U''_1\,\}dp_m + \{P'(\beta)[(-p_m m)U'_1]$$

$$+\,P(\beta)(D'_S\, S'_\beta)(-p_m m)U''_1 - P(\beta)(-p_m m)L'_\beta U''_1\,\}dc + \{P'(\beta)[(-1)U'_1]$$

$$-\,P(\beta)(-1)L'_\beta U''_1 + P'(\beta)[U'_2] + P(\beta)(D'_S\, S'_\beta)(-1)U''_1$$

$$+\,[1 - P(\beta)]L'_\beta U''_2\,\}dR + \{P'(\beta)[(D'_s)U'_1] - P(\beta)L'_\beta[U''_1\,(D'_S)]$$

$$+\,P(\beta)(-D''_{SS})U'_1 + P(\beta)(D'_S\, S'_\beta)(D'_S)U''_1\,\}dS$$

$$+\,\{P'(\beta)[U'_1(-cp_m - L'_m) + D'_m U'_1]$$

$$+\,P(\beta)U''_1\,[(cp_m + L'_m) + D'_m][(D'_S\, S'_\beta) - L'_\beta]\}dm$$

To simplify, let

$$X = \frac{\partial^2 EU}{\partial \beta^2} = P''(\beta)[\mathrm{U}_1 - \mathrm{U}_2\ ] + 2P'(\beta)U'_1\{[-L'_\beta - D'_S\, S'_\beta]\} + P(\beta)\{[L''_{\beta\beta}\ (U''_1 - U'_1)] +$$

$$U''_1\left(D'_S\, S'_\beta\right)(D'_S\, S'_\beta - L'_\beta) + [(D''_{SS}\, S'_\beta) + D'_S S''_{\beta\beta}]U'_1\} +$$

$$[1 - P(\beta)]\left[\left(-L''_{\beta\beta}\right)U'_2 + L''_{\beta\beta}U''_2\right] + U''(\beta)$$

Rearrange:

$$\begin{aligned} Xd\beta = &-\{P'(\beta)[(1-t)U'_1] - P(\beta)(1-t)L'_\beta U''_1 + P'(\beta)[(1-t)U'_2] + P(\beta)\left(D'_S\, S'_\beta\right)(1 \\ &- t)U''_1 - [1 - P(\beta)](1-t)L'_\beta U''_2\}dY - \{P'(\beta)[YU'_1] - P(\beta)YL'_\beta U''_1 \\ &+ P'(\beta)[YU'_2] + P(\beta)\left(D'_S\, S'_\beta\right)(Y)U''_1 - [1 - P(\beta)]YL'_\beta U''_2\}d(1-t) \\ &- \{P'(\beta)[(-cm)U'_1] + P(\beta)\left(D'_S\, S'_\beta\right)(-cm)U''_1 - P(\beta)(-cm)L'_\beta U''_1\}dp_m \\ &- \{P'(\beta)[(-p_m m)U'_1] + P(\beta)\left(D'_S\, S'_\beta\right)(-p_m m)U''_1 - P(\beta)(-p_m m)L'_\beta U''_1\}dc \\ &- \{P'(\beta)[(-1)U'_1] - P(\beta)(-1)L'_\beta U''_1 + P'(\beta)[U'_2] + P(\beta)\left(D'_S\, S'_\beta\right)(-1)U''_1 \\ &+ [1 - P(\beta)]L'_\beta U''_2\}dR + \{P'(\beta)[(D'_S)U'_1] - P(\beta)L'_\beta[U''_1\,(D'_S)] \\ &+ P(\beta)(D''_{SS})U'_1 + P(\beta)\left(D'_S\, S'_\beta\right)(D'_S)U''_1\}dS \\ &- \{P'(\beta)[U'_1(-cp_m - L'_m) + D'_m U'_1] \\ &+ P(\beta)U''_1[(cp_m + L'_m) + D'_m]\left[\left(D'_S\, S'_\beta\right) - L'_\beta\right]\}dm \end{aligned}$$

Then

$$d\beta =$$

$$-\left\{\frac{P'(\beta)[(1-t)U'_1] - P(\beta)(1-t)L'_\beta U''_1 + P'(\beta)[(1-t)U'_2] + P(\beta)\left(D'_S\, S'_\beta\right)(1-t)U''_1 - [1-P(\beta)](1-t)L'_\beta U''_2}{X}\right\}dY -$$

$$\left\{\frac{\{P'(\beta)[YU'_1] - P(\beta)YL'_\beta U''_1 + P'(\beta)[YU'_2] + P(\beta)\left(D'_S\, S'_\beta\right)(Y)U''_1 - [1-P(\beta)]YL'_\beta U''_2}{X}\right\}d(1-t) -$$

$$\left\{\frac{P'(\beta)[(-cm)U'_1]+P(\beta)\left(D'_S\,S'_\beta\right)(-cm)U''_1-P(\beta)(-cm)L'_\beta U''_1}{X}\right\}dp_m-$$

$$\left\{\frac{P'(\beta)[(-p_m m)U'_1]+P(\beta)\left(D'_S\,S'_\beta\right)(-p_m m)U''_1-P(\beta)(-p_m m)L'_\beta U''_1}{X}\right\}dc-$$

$$\left\{\frac{P'(\beta)[(-1)U'_1]-P(\beta)(-1)L'_\beta U''_1+P'(\beta)[U'_2]+P(\beta)\left(D'_S\,S'_\beta\right)(-1)U''_1+[1-P(\beta)]L'_\beta U''_2}{X}\right\}dR+$$

$$\left\{\frac{P'(\beta)[(D'_S)U'_1]-P(\beta)L'_\beta[U''_1\,(D'_S)]+P(\beta)(D''_{SS})U'_1+P(\beta)\left(D'_S\,S'_\beta\right)(D'_S)U''_1}{X}\right\}dS-$$

$$\left\{\frac{P'(\beta)[U'_1(-cp_m-L'_m)+D'_m U'_1]+P(\beta)U''_1\,[(cp_m+L'_m)+D'_m]\left[\left(D'_S\,S'_\beta\right)-L'_\beta\right]}{X}\right\}d\mathrm{m}$$

Appendix 4:

Max

$EU^{indivudual} = \int\{P(\beta_{(c)})\{U\big[\big(Y - P\,(\beta_{(c)}\big)(1-c)p_m m_{(c)} - cp_m m_{(c)} - L\big(m_{(c)}, \beta_{(c)}\big)\big] +$

$D\big[S\,(\beta_{(c)}\big), m_{(c)}\,]\} + \big(1 - P(\beta_{(c)})\big)U\big[Y - P\,\big(\beta_{(c)}\big)(1-c)p_m m_{(c)} - L\big(\beta_{(c)}\big)\,\big] +$

$U(\beta_{(c)})\}f(\beta)d(\beta)$

Where $U_1 = U[Y - tY - cmp_m - R - L(m,\beta)] + D[S(\beta), m]$

$U_2 = U(Y - tY - R - L(\beta))$

The F.O.C with respect to changes in copayment rate *c* can be derived as:

$$\frac{\partial EU^{indidual}}{\partial c} = \int\{[-P_\beta p_m m^* U_1'] + [P_\beta p_m m^* U_2'] - [P_\beta^2 p_m m^* U_2'] + \big[P_\beta' \beta_c U_1 - P_\beta' \beta_c U_2\big]$$

$$+ \{\big[P_\beta\big(-P_\beta'\big)\beta_c(1-c)p_m m^*\big] - [P_\beta^2(1-c)p_m(m_c)] - \big[P_\beta p_m c(m_c)\big]$$

$$- \big[P_\beta L_m'(m_c)\big] - [P_\beta L_\beta' \beta_c]\}\,U_1' + [P_\beta \beta_c D_S' S_\beta'\,]U_1' - [P_\beta D_m'(m_c)U_1'] + \{[(1$$

$$- P_\beta)(-P_\beta')\beta_c(1-c)p_m m^*] + [(1-P_\beta)(-P_\beta')(1-c)p_m(m_c)] - [(1$$

$$- P_\beta)L_\beta' \beta_c]\}U_2' + U_\beta' \beta_c\}f(\beta)d(\beta)$$

With the constraints 3 and 4, we can simplify the equation above to become

$$\frac{\partial EU^{individual}}{\partial c} =$$

$$\int\{P\,(\beta)p_m m[(P(\beta)-1)U_1' + (1-P(\beta))U_2'] - P(\beta)(1-c)p_m m_c[P(\beta)U_1' + (1-$$

$$P(\beta))U_2'] - P'(\beta)(1-c)\,\beta_c p_m m[P(\beta)U_1' + (1-P(\beta))U_2']\}\,f(\beta)d(\beta) \qquad (12)$$

Appendix 5 The ordered probit model result for alcohol consumption model in 2007

Table A.1. Sample distribution of level of alcohol consumption for 2007.

Level of alcohol consumption	Sample	Percent	Cumulate
0 (No alcohol consumption)	3,235	71.35	71.35
1 (less than once per month)	453	9.99	81.34
2 (once or twice per month)	253	5.58	86.92
3 (once per week)	143	3.35	90.07
4 (two or three times per week)	174	3.84	93.91
5 (daily)	276	6.09	100.00
Total	4,534	100	-

Table A.2. The probability distribution of ordered *Probit* model for 2007.

Level of alcohol consumption	Probability distribution of order *Probit* model
1 (less than once per month)	10.66 %
2 (once or twice per month)	5.20%
3 (once per week)	2.61%
4 (two or three times per week)	2.79%
5 (daily)	3.26%