C H L R W O R K I N G P A P E R S E R I E S
中 国 人 力 资 本 与 劳 动 经 济 研 究 中 心 工 作 论 文 系 列

Coverage Matters: Impacts of National Health Insurance on Health Care Utilization and Mortality of the Previously Uninsured Elderly in Taiwan

Kang-Hung Chang

Working Paper 7
December 2009

CHINA CENTER FOR HUMAN CAPITAL AND LABOR MARKET RESEARCH
CENTRAL UNIVERSITY OF FINANCE AND ECONOMICS
中央财经大学中国人力资本与劳动经济研究中心
39 Xueyuan South Road, Haidian District, Beijing, China 100081
Web: http://humancapital.cufe.edu.cn
Phone & Fax: 86-010-62288298

Coverage Matters: Impacts of National Health Insurance on Health Care Utilization and Mortality of the Previously Uninsured Elderly in Taiwan

Kang-Hung Chang

July 2009

Abstract

On March 1 1995, Taiwan initiated its National Health Insurance (NHI) program that mandated insurance coverage to its 21 million citizens including 8 million previously uninsured. The mandate generated arguably exogenous variation in insurance status among the previously uninsured. Exploiting this feature, this paper adopts a difference-in-differences method, along with a longitudinal survey of the elderly, to estimate the NHI effects on health care utilization and mortality of the previously uninsured elderly relative to their continuously insured counterparts. This study finds that compared to the continuously insured elderly, utilization for the previously uninsured elderly was largely increased by NHI. Corresponding to the increase in utilization, the mortality hazard ratio of the previously uninsured to the continuously insured elderly dropped from 1.3 in the pre-NHI period to close to 1 in the post-NHI period, suggesting that NHI improved the health of the previously uninsured elderly through health care.

1. Introduction

The effects of health insurance have long been an interest among researchers and policy makers. In particular, how health insurance affects people's utilization behavior and health outcomes is an important question when a government considers providing insurance coverage to the public. Since the famous RAND Health Insurance Experiment in the 1970s, a large body of studies investigating insurance effects has accumulated in the literature. Researchers, however, have not yet reached a unanimous conclusion of the insurance effects on health outcomes despite their agreement that insurance affects utilization.

There are numerous reasons why there is a lack of consensus among researchers on the insurance effects on health outcomes (Levy and Meltzer 2004). One of the major reasons is that causation between insurance status and health may run in both directions. For example, while insurance provides people access to medical care that might improve health, it is also true that—at least in the United States—insurance companies often screen the health of their applicants and relatively healthy applicants are more likely to be approved. This could create a positive association between insurance and health that does not reflect a causal effect of insurance.

To tackle this problem, more and more studies have exploited exogenous variation in insurance status generated by so-called "natural experiments", which usually refer to a policy or an institutional change that is essentially uncorrelated with the health of its targeted subjects (Card et al. 2004; Chen et al. 2007; Cheng and Chiang 1997; Currie and Gruber 1996a, 1996b, 1997; Haas et al. 1993a, 1993b; Hanratty 1996; Lichtenberg 2002; Polsky et al. 2006; Wen et al. 2008). If the policy-generated variation in insurance status is uncorrelated with the subjects' health, it is feasible to identify the insurance effect on health. Following this line of research, this

paper examines the effects of a rare large-scale "natural experiment" on health insurance in Taiwan in the mid-1990s.

On March 1, 1995, Taiwan initiated its National Health Insurance (NHI) program that mandated insurance coverage to its 21 million citizens, including 8 million who had been previously uninsured. The previously uninsured were required to enroll in NHI regardless of their health.[1] In addition, the strict mandate eliminated the possibility for the previously uninsured to opt out. These two facts together generated arguably exogenous variation in insurance status. On the other hand, others who had been previously insured by various social insurance programs were automatically transferred to NHI and enjoyed a similar range of medical benefits as before. Exploiting these features, this paper adopts a difference-in-differences (DD) method to examine the NHI effects on utilization behavior and mortality. Due to data availability, this paper focuses on the elderly.

Several studies such as Cheng and Chiang (1997), Chen et al. (2007), Wen et al. (2008), Zimmer et al. (2002) and Zimmer et al. (2005) have also investigated the effects of Taiwan's NHI on utilization and health. The majority consensus among these studies is that NHI increased utilization for the previously uninsured. Nevertheless, while some of them claim that NHI also improved the health of the previously uninsured, others disagree.

In particular, Chen et al. (2007) used the same survey of the elderly that is also used in this chapter.[2] They find that NHI largely increased utilization for the previously uninsured elderly but did not improve their one-year mortality relative to their continuously insured

[1] In fact, no matter when the previously uninsured actually signed up for NHI, their coverage automatically took effect on March 1, 1995.
[2] Chen et al. (2007) was published after this paper had begun in 2006.

counterparts.[3] They attribute the lack of evidence on mortality to several possible reasons. For example, they argue that one-year mortality may not be a sensitive measure of health and that their sample period—from 1989 to 1999, which includes only covers 4 years after 1995—may not be long enough to detect any NHI effect. Other explanations they provide are related with effectiveness and quality of health care in producing health.

In our view, however, there are two other possibilities. First, they did not fully utilize the mortality information. They only used two pre-NHI (1989 and 1993) and two post-NHI yearly mortality rates (1996 and 1999), while mortality information from other years was simply ignored. In this study, we are able to use more recent and detailed monthly mortality data up to the end of 2003. Our study period thus covers 8 years after NHI was implemented. Moreover, instead of looking at limited discrete points, we utilize every piece of monthly mortality information throughout our entire analysis period from 1993 to 2003.

Second, the demarcation between the previously uninsured and continuously insured elderly in Chen et al. (2007) was problematic. They imputed insurance status for the elderly in the pre-NHI period and assumed their status remained unchanged until 1995 when NHI was initiated.[4] However, we examine the pre-NHI insurance history of the elderly using both administrative data and a telephone follow-up in 1991 of the same elderly survey, which they did not use; we find that many of the elderly changed their insurance status in the pre-NHI period. In particular, of the elderly in the survey whose insurance status was available in both 1989 and 1993, about 26% of them changed their insurance status, either from uninsured to insured or vice

[3] They also examined the NHI effect on self-reported health but did not find evidence of an effect on it, either.
[4] They imputed insurance status because no insurance information was available in the initial survey in 1989. Another wave of the survey in 1993 does have insurance information. However, only a subset of the initial sample appeared in 1993.

versa.[5] This implies that their imputed insurance status very likely has led to wrong demarcation between the treatment and control group, which is essential in their difference-in-differences analysis. (See Section 2 and Appendix 2 for more details.)

Therefore, to get a more accurate demarcation, we use insurance status in 1993, which is the available insurance information closest to 1995, to reduce the possibility of changing insurance status before the implementation of NHI.

The major findings of this chapter show that NHI largely increased the utilization of the previously uninsured elderly relative to their continuously insured counterparts. Correspondingly, the mortality hazard ratio of the previously uninsured elderly to their continuously insured counterparts significantly dropped from 1.3 in the pre-NHI period to close to one in the post-NHI period, suggesting that NHI did improve the health of the previously uninsured elderly through health care.

The rest of this chapter is organized as follows. The second section introduces the institutional background. The third section illustrates the empirical method. The fourth section describes the data. The fifth section reports the estimation results. The major findings are then concluded in the last section. Appendix 1 demonstrates how the insured and uninsured elderly in the pre-NHI period are defined. A detailed comparison between this paper and Chen et al. (2007) is provided in Appendix 2.

2. Institutional Background

Health Insurance Before 1995

[5] There were 2,887 elderly whose insurance status in 1989 and 1993 were both available. Among them, 672 changed from uninsured to insured, 75 from insured to uninsured and the rest did not change.

At the end of 1994, about 2.3 million people in Taiwan (11% of the entire population) were aged 60 and older. Among them, about 75% were insured by four social insurance programs: Farmers Health Insurance (FHI), Government Employees Insurance (GEI), Labor Insurance (LI) and Veterans Insurance (VI).[6] As suggested by their names, FHI covered farmers; GEI covered government employees and school teachers; LI covered private sector workers; VI covered veterans. In 1994, FHI, GEI, LI and VI respectively accounted for 45%, 20%, 18% and 17% of the insured elderly.[7] Besides social insurance, there was virtually no comprehensive private insurance at the time.[8]

These programs share six common features. First, they were employment-based and generally covered only active workers except for GEI and VI, which also provided coverage to retirees and dependents.[9] Second, they were mandatory and all eligible individuals were required to enroll in one of these programs. Third, they provided comprehensive medical benefits including outpatient, inpatient, emergency care and prescription drugs.[10] Fourth, they all adopted a single-payer fee-for-service (FFS) system.[11] Fifth, there was virtually no copayment for any

[6] Several other social insurance programs also existed at the time but only accounted for a very small portion of the elderly population.
[7] All these numbers are my calculations using administrative statistics from Bureau of Central Trust, Bureau of Labor Insurance, Bureau of National Health Insurance, Veteran Affairs Commission and Ministry of the Interior.
[8] More precisely, private insurance provided only very limited coverage and generally did not cover any outpatient care (Liu and Chen 2002; Cheng 2003).
[9] Since FHI and LI were supposed to cover only active farmers and private sector workers, it seems puzzling at first glance that many elderly were insured by the two programs in 1994. This was actually a result of loose law enforcement. According to the law, farmers and workers could sign up FHI and LI by becoming members of some famers association or association of some occupation or union. By law, these associations were supposed to screen and track their members' work status. In practice, however, screening and tracking work status is difficult. Therefore, many elderly retained their insurance through this loophole even after they had retired.
[10] In addition to medical care, they also provide maternity, injury, disability, death, and retirement benefits.
[11] Each program had its own contracted provider network. According to Cheng and Chiang (1997), roughly 85% of hospitals and 70% of clinics in Taiwan were contracted with these social insurance programs in 1994. Care providers within each network were reimbursed solely by a government agency based on a fixed fee schedule. Moreover, insurees had the right to choose any provider within the network without any referral.

service.[12] Sixth, the insurance premium was generally shared among government, employers (if applicable) and insurees.

Given the nature of the pre-NHI insurance market, the remaining 25% of the elderly was left uninsured. Many of them were women and not working. In general, the uninsured elderly had to pay out-of-pocket for their health care expenditures and utilized less health care than their insured counterparts (Cheng and Chiang 1997).

National Health Insurance

After a decade of planning, the government decided to consolidate all social insurance programs into a universal and compulsory National Health Insurance (NHI). The National Health Insurance Act (NHIA) was passed in the legislature on July 19, 1994 and took effect on March 1, 1995. Meanwhile, a new government agency called the Bureau of National Health Insurance was established to administer NHI.

NHIA required all of the previously uninsured to enroll in NHI and insurees of the various social insurance programs to be automatically transferred to NHI.[13] Due to its mandatory and universal nature, NHI extended its coverage quickly. By the end of 1996, about 93% of the population had enrolled in NHI. Among the elderly aged 60 and older, the coverage rate was near 100%.

[12] Patients typically only paid a fixed "registration fee" NT$ 50 (US$ 1.7) for each outpatient visit.
[13] Active military personnel were not covered by NHI until 2001. These social insurance programs still exist today and continue to provide non-medical benefits.

In general, NHI provides a similar wide range of medical benefits as previous social insurance programs did.[14] The insurance premium is also shared among government, employers (if applicable) and insurees. For low-income people and veterans, their premium is entirely paid by the government.

One feature that distinguishes NHI from previous programs is its copayment scheme. Typically, one pays an amount of NT$ 100 to NT$ 200 (roughly US$ 3.3 to US$ 6.7) copayment for each outpatient visit. For a hospital stay, the coinsurance rate varies from 5% to 30% depending on the length of stay and type of room, and the total copayment is subject to an upper limit. Copayments are waived for low-income people, veterans, and people with some major illness such as cancer, end-stage renal disease, etc.

NHI also has its own contracted provider network. According to the Department of Health, about 98% of hospitals and 91% of clinics contracted with NHI in 1996. In its early stage, NHI adopted a FFS system to reimburse its contracted care providers. Unfortunately, this system was unable to contain medical care expenditures, and NHI faced its first budget deficit two years after its inception.

To tackle its growing budget woe, NHI adopted a series of measures. For example, it imposed a new copayment on prescription drugs in 1999 and raised the insurance premium by 7 percent in 2002. It also raised copayments for patients who have "excessive" doctor visits.[15] In addition, a Global Budget System (GBS) that uses a predetermined budget to control expenditures has been applied to all medical services since 1998 (Hsueh, Lee and Huang 2002;

[14] Except that NHI has more preventive care and home care benefits

[15] For example, the copayment is raised by NT$ 50 starting on one's 49th visit within a year and by NT$100 starting on one's 157th visit (Liu and Chen 2002).

Lee and Jones 2004). Most recently, a Diagnosis-Related Group (DRG) system that reimburses hospital service based on classifications of cases that use similar hospital resources was launched in 2008.

Uninsurance Trend: 1985-2005

While it is well-known that uninsurance in Taiwan was mostly eliminated by NHI, it is relatively less noticed that the uninsurance rate actually had been declining fast as early as a decade before. Figure 1 shows the uninsurance rate in Taiwan from 1985 to 2005.[16] The solid line illustrates the uninsurance rate of the whole population and the dashed line is that of the elderly 60 and older. Both lines show a downward trend in the pre-NHI era (1985-1994). The downtrend in the pre-NHI era was mainly resulted from a series of expansions in the major social insurance programs. For example, GEI extended its coverage to private school staff in 1980, to dependents of government employees in 1982, to retired private school staff and their spouses in 1985 and to dependents of private school staff in 1990; FHI was initiated in 1985 and became a mandate for farmers in 1989 (Peabody *et al.* 1997; Chiang 1997). The decline was particularly sharp for the elderly between 1987 and 1989 when FHI was quickly expanded. FHI had a particularly large impact on the elderly because farmers constituted a major component of the elderly population at the time.

[16] Numbers are my own calculations using statistics from the following sources. Population statistics are from *Statistical Yearbook of Interior* published by the Ministry of Interior, which is available at http://www.moi.gov.tw/stat/english/year.asp. Numbers of GEI insurees are from *GEI Statistics* published by Bank of Taiwan (formerly by Bureau of Central Trust), which is available at http://www.bot.com.tw/GESSI/Statics/default.htm. Numbers of FHI and LI insurees are from *Annual Report* published by Bureau of Labor Insurance, which is available at http://www.bli.gov.tw/en/. Numbers of VI insurees are kindly provided by Veteran Affairs Commission (VAC). They are not available on-line but can be requested from the VAC.

The downtrend of uninsurance in the pre-NHI period has an important implication—many elderly people changed their insurance status in the pre-NHI period. This suggests that we should use the insurance status right before the initiation of NHI in 1995 to demarcate between the previously uninsured and the continuously insured elderly.

3. Empirical Framework

Health Care Utilization

Our main identification strategy relies on the fact that all previously uninsured elderly were required to enroll in NHI regardless of their health. In practice, no matter when they actually enrolled, their coverage automatically took effect on March 1, 1995. This mandatory feature of NHI eliminated the possibility for them to opt out and generated exogenous variation in their insurance status before and after 1995.

Suppose we observe the average utilization outcomes of the previously uninsured elderly before and after NHI was implemented, we could have used the observed difference in outcomes to measure the NHI effect on utilization. However, this difference is likely to be confounded, especially when the two outcomes are far apart in time, by other factors such as aging, environmental change, medical technology improvement etc.[17] The challenge is thus how to filter out the confoundedness.

[17] Another concern is that the previously uninsured elderly may have anticipated the coming of NHI and delayed their pre-NHI utilization until 1995. This anticipatory effect could possibly lead to an overestimate of the NHI effect on utilization. However, the earliest time that the public in Taiwan learned that NHI will be implemented in March 1995 was in July 1994 after the *National Health Insurance Act* was passed in the legislature. In our later analysis, we compare utilization of the elderly in 1993, 1996, 1999 and 2003. Back in 1993, nobody knew if and when NHI will come. In addition, if the previously uninsured elderly really repressed their utilization in 1994, this pent-up demand was more likely to be satisfied in 1995 right after NHI was implemented than 1996 or later. Therefore, the anticipatory effect should be of less concern in our analysis.

One natural choice is to use the difference in outcomes experienced by their continuously insured counterparts and adopt a difference-in-differences (DD) strategy under two standard assumptions. The first assumption is that the continuously insured elderly were not affected in terms of utilization outcomes by transferring from previous social insurance programs to NHI.[18] The second assumption is that on average both the previously uninsured and the continuously insured elderly would have experienced the same confoundedness in the absence of NHI. [19] We discuss the validity of the first assumption in more detail below.

The continuously insured elderly could possibly be affected by NHI in two aspects. First, while under NHI they still enjoyed a similar wide range of medical benefits as before, they now had to pay copayments, which were virtually absent under the previous programs. Cheng and Chiang (1997) compare the utilizations of the continuously insured adults before and after 1995 and find that the new copayment scheme seemed to have only insignificant effect on curbing utilization. They suggest that the effect of copayment on utilization was likely offset by more contracted medical care providers under NHI and relatively inexpensive cost sharing.

Second, the inclusion of the previously uninsured into NHI may have caused an adverse effect on the continuously insured, if there was not sufficient medical care supply to serve the sudden rise in demand. Nevertheless, medical care supply actually outgrew the population in Taiwan from 1986 to 1995. Specifically, while the population increased by 10% during this

[18] Or, loosely speaking, the NHI effect on the continuously insured elderly was so minimal that changes in their outcomes mainly reflect non-NHI factors.
[19] This assumption is generally not testable unless there was a group not subject to NHI. However, if such a group really existed, we would have used it as a control group to measure the common confoundedness.

period, the numbers of medical personnel, hospitals and clinics grew by 70%, 34% and 37% respectively.[20]

Under these assumptions, we use the following two DD models to estimate the NHI effect on utilization.

$$(1)\quad Y_{it} = \beta_0 + \beta_1 UI_i + \beta_2 YR_t + \beta_3 UI_i \times YR_t + X_i B + \varepsilon_{it},$$

where *i* indexes individuals; *t* indexes time; *Y* is a dummy variable indicating one's utilization of certain type of care in a given time period; *UI* is a dummy variable indicating the previously uninsured elderly; *YR* is a year dummy indicating the year in the post-NHI period; *X* is a row vector of pre-NHI controls including age, sex, education, ethnicity, marriage, residence region, living arrangement, employment history, income, self-reported health and health behavior;[21] *B* is a column vector of coefficients corresponding to the variables in *X*; ε is an unobserved error term. Equation (1) is a linear probability model and estimated by pooled OLS.[22]

Conditional on pre-NHI characteristics, β_1 measures the outcome difference between the previously uninsured and the continuously insured elderly in the pre-NHI period; β_2 picks up the common confoundedness; β_3 assesses the difference in outcome differences between the elderly groups before and after 1995, that is, the NHI effect.

[20] Numbers are calculated based on official statistics released by the Department of Health and available on its website http://www.doh.gov.tw/EN2006/index_EN.aspx. Part of this growth in supply was resulted from the government's planning in anticipation of NHI, and another part was from the response of the private medical care providers who foresaw the potential profits brought by NHI.

[21] Living arrangement is to capture the possible non-monetary resources provided by their adult children with whom they live; employment history is highly correlated with their pre-NHI insurance status as well as their lifestyle which is further correlated with their health and utilization. For example, both farmers and government employees tend to be insured in the pre-NHI period but they also tend to have different lifestyles. In particular, farmers are more likely to involve in strenuous work, while government employees tend to live a sedentary lifestyle.

[22] We also estimated a probit model. However, the estimated NHI effects are similar to the linear probability model.

To reduce the possible bias caused by non-random attrition, an issue will be discussed in more detail in the data section, we estimate equation (1) using three balanced two-year pooled panels with one year in the pre-NHI period and another in the post-NHI period—1993 versus 1996, 1993 versus 1999 and 1993 versus 2003. This allows us to estimate the NHI effect in the short-run as well as in the long-run. Every elderly subject is observed in both years of each pair. We pool in pairs and run separate regressions in order to retain as many observations as possible.[23] In addition, we use cluster-robust standard errors for statistical inferences because of the pooling.

In equation (1), the sample compositions of the three separate regressions are partially different. In other words, the NHI effects across years are estimated based on partially different samples. Alternatively, we estimate the following pooling model with the sample confined to the same group of elderly.

$$(2)\quad Y_{it} = \beta_0 + \beta_1 UI_i + \beta_2 YR96_t + \beta_3 YR99_t + \beta_4 YR03_t + \beta_5 UI_i \times YR96_t + \beta_6 UI_i \times YR99_t + \beta_7 UI_i \times YR03_t + X_i B + \varepsilon_{it},$$

where YR96, YR99 and YR03 are year dummies indicating 1996, 1999 and 2003 respectively; other notations are the same as before.

Equation (2) is estimated using a balanced panel pooled across all 4 years: 1993, 1996, 1999 and 2003. The three interaction terms measure the NHI effect in 1996, 1999 and 2003 relative to 1993 using the identical sample. Again, cluster-robust standard errors are used for inferences. Because we restrict the pooled sample to be balanced across all four years, the

[23] The more years we include in one regression, the more observations we lose in order to keep a balanced pooled panel.

sample size is much smaller, compared with the three pooled pairs used in equation (1). Later, we compare results from both models to see if sample attrition causes any difference.

Moreover, we devise the following more general DD model to provide suggestive evidence of the validity of the first assumption of our DD strategy. We divide the continuously insured elderly into five previous social insurance programs.

$$(3)\quad Y_{it} = \beta_0 + \beta_1 UI_i + \beta_2 GEI_i + \beta_3 LI_i + \beta_4 VI_i + \beta_5 OI_i + \beta_6 YR_t + \beta_7 UI_i \times YR_t + \beta_8 GEI_i \times YR_t + \beta_9 LI_i \times YR_t + \beta_{10} VI_i \times YR_t + \beta_{11} OI_i \times YR_t + X_i B + \varepsilon_{it},$$

where *GEI*, *LI*, *VI*, and *OI* are dummy variables indicating the elderly who are previously covered by GEI, LI, VI and OI (meaning other social insurance programs) respectively; all other notations are the same as in equation (1); note that the reference group here is FHI, the largest insurance group in the pre-NHI period. Again, equation (3) is estimated by OLS using three separate two-year pooled panels.

If we maintain the common time trend assumption but relax the first assumption, β_8 in equation (3) actually measures the "NHI effect" for those who transferred from GEI to NHI relative to the "NHI effect" for those who transferred from FHI to NHI. Likewise, β_9, β_{10} and β_{11} measure the "NHI effect" for those who shifted from LI, VI and OI to NHI respectively. If the continuously insured elderly groups were really affected by NHI, it is likely that the "NHI effects" for these five different groups were also different because these programs were different from each other.[24] This suggests a test of the following null hypothesis.

Hypothesis: $\beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$.

[24] Cheng and Chiang (1998) point out the three major programs, GEI, LI and FHI, differ in their medical availability.

This null hypothesis states that either the continuously insured elderly were not affected by transferring from former insurance programs to NHI or they were affected to the same extent. However, the latter possibility seems less probable.

Mortality Hazard Ratio

In general, we follow the same identification strategy and assumptions as in the utilization analysis. However, in contrast to the linear DD model of utilization, we incorporate the DD design into an exponential hazard function in order to fully exploit the mortality data. Let us define the hazard function as a conditional instantaneous rate of dying at any given time point as follows (throughout this chapter, "hazard" always refers to mortality hazard).

$$(4)\quad h(t) = \lim_{\Delta t \to 0} \frac{\Pr\,(t \le T < t + \Delta t | T \ge t)}{\Delta t};\; T = \{0 < t < \infty\},$$

where h is the hazard function; T is survival time that takes on only non-negative values, t; Pr $(\cdot)$ is the probability that an individual dies at some point between t and $t+\Delta t$ conditional on having survived for t units of time.

Further, let us model the hazard function as an exponential function with a DD design as follows.

$$(5)\quad h(t_i) = \exp(\beta_0 + \beta_1 UI_i + \beta_2 POST_i(t_i) + \beta_3 UI_i \times POST_i(t_i) + X_i B),$$

where t_i is the number of months that individual i was alive during our analysis period from 1993 to end of 2003; *POST* is an indicator for the post-NHI period and depends on one's survival time, t; other notations are the same as in equation (1). In the set of baseline controls, X, we

additionally add age-squared and age-cubic. Based on this hazard function, *t* is assumed to be exponentially distributed and the survival function can be derived accordingly to construct a likelihood function stated below; the parameters are then estimated by maximum likelihood method.

Based on the hazard function, the log-likelihood function can be constructed accordingly as $lnL = \sum_{i=1}^{n}\{d_i lnf(t_i) + (1-d_i)lnS(t_i)\}$, where d_i is an indicator of death by the end of our analysis period; $f(t_i)$ is the density function of t_i and equals to $h(t_i)exp\left\{-\int_0^{t_i} h(u)du\right\}$; $S(t_i)$ is the so-called survivor function that equals to $exp\left\{-\int_0^{t_i} h(u)du\right\}$. Note that if one was still alive at the end of the analysis period, her t_i equals to the length of the analysis period and her contribution to the log likelihood is $lnS(t_i)$; otherwise, her contribution is $lnf(t_i)$.

In equation (5), $\exp(\beta_0 + \beta_2 POST_i(t_i))$ represents the baseline hazard common to both the previously uninsured and continuously insured elderly. Note that the baseline hazard can change across periods because of the time-varying variable, *POST*. Equation (5) can be viewed as a *piecewise constant hazard model* because it allows the baseline hazard to vary across the pre- and post-NHI periods but remain constant within each period. Assuming a constant hazard in each period may not be sensible in the context of elderly. However, for our DD strategy, we only need to estimate the change in baseline hazard across periods. The exact shape of the baseline hazard function is not our main concern.

In equation (5), conditional on the pre-NHI controls, $\exp(\beta_1)$ measures the ratio of the hazard of the previously uninsured elderly to the hazard of the continuously insured elderly in the pre-NHI period, while $\exp(\beta_1 + \beta_3)$ assesses that hazard ratio in the post-NHI period, and

exp (β_2) is the pre- versus post-NHI within-group confoundedness which is assumed to be common for both groups.

Alternatively, we can interpret the βs in terms of log hazards. By taking natural logarithm of equation (5), we turn the hazard function into a log-hazard function and β_1 is the difference in log-hazards in the pre-NHI period, β_2 is the common confoundedness, and β_3 is the difference in differences in log hazards. However, hazard ratios are more interpretable than log hazards.

4. Data

A Longitudinal Elderly Survey

We use a longitudinal survey of the elderly called *the Survey of Health and Living Status of the Middle-aged and the Elderly in Taiwan* (referred to as *the survey* hereafter) administered by *the Bureau of Health Promotion* (BOH) in Taiwan (formerly known as *Institute of Family Planning*).[25] The survey contains rich information regarding demographics, health care utilization, health outcomes, health insurance, income, employment history etc. The survey drew a nationally representative elderly sample of 4,049 who were aged 60 and older in 1989. The elderly were then followed in 1991, 1993, 1996, 1999 and 2003.[26]

In our analysis of utilization, we only use the 1993, 1996, 1999 and 2003 surveys for the following two reasons. First, the 1989 survey contains no health insurance information and its

[25] Although the middle-aged are mentioned in the title of the survey, we do not use the middle-aged because they were added into the survey in 1996 and we do not know their pre-NHI insurance status.
[26] All waves were conducted in person except for the 1991 survey, which was done by telephone. Every wave was generally administered from March to June; the completion rate for each wave is over 90%. In 1996, the survey added in a middle-aged sample of 55 to 66 years old. The middle-aged sample is not used in this study because it has no pre-NHI insurance information.

utilization questions are different from those in latter surveys (see Appendix 1 for more details). Second, the 1991 survey lacks health utilization information. In addition, we drop the privately insured elderly and those with unknown insurance status in 1993.[27] In the end, our final sample consists of 785 uninsured and 2,351 insured elderly in 1993.

As shown in Table 1, FHI, GEI and VI amount to 39%, 15% and 12% of the sample respectively, while LI accounts for only 5% of the sample. The insurance structure reflects the agriculture-oriented economy for this generation as well as a massive influx of troops from mainland China to Taiwan around 1949 due to a civil war.

The survey is supplemented with three sources of mortality data. The survey itself collects information about death month and year of each deceased elderly up to the end of 2003. To confirm with administrative data, the survey uses national ID numbers of the elderly to link them to mortality records at the Department of Health (DOH) and Ministry of the Interior (MOI). However, for various reasons, about 6% of the DOH death records are inconsistent, either in death month or year, with the survey's own collection, and only a rather small number of deaths are successfully linked to MOI data.[28] Instead of dropping the mismatched cases, we choose to use both the survey's collection and the DOH data to estimate the hazard model and present both sets of results. From the beginning of 1993 to the end of 2003, 1,367 and 1,389 out of the total 3,136 elderly had died according to the survey's collection and the DOH data, respectively.

Characteristics of the Elderly in the Pre-NHI Period

[27] There are 16 privately insured and one with unknown insurance status. See appendix 1 for more details.
[28] According to the Bureau of Health Promotion, some national ID numbers provided by the elderly are wrong and some others' ID numbers are not even available. However, we are not told about how many cases have this problem.

Table 2 summarizes the characteristics of the uninsured and the insured elderly in 1993. Compared with their insured counterparts, the uninsured elderly are more likely to be women, unmarried or widows, Minnan people, and live with their children in an urban area in the north region of Taiwan. They also tend to be less educated, less likely to be working and receive less monthly income. Meanwhile, they are more likely to live with their adult children, too.

As expected, their insurance status is correlated with their current or past occupation as the insured elderly are much more likely to have ever worked as famers, government employees and military personnel than the uninsured elderly.

In terms of health outcomes, the uninsured elderly are less healthy and more likely to die than the insured elderly. Surprisingly, the uninsured elderly also live slightly healthier in terms of smoking and betel nut chewing.[29]

Utilization Variables

To measure their utilization behavior, we use information about whether they have ever foregone doctor visits due to lack of money in a 3-month period, their outpatient visits in a month, hospitalizations and emergency room (ER) visits in a year. See Appendix 1 for original survey questions in Chinese and their English translations.

Table 3 summarizes these variables across years. Column (1) and (2) in the first panel show that the probability of forgoing doctor visits due to lack of money drops by 4 percentage points for the previously uninsured elderly from 1993 to 1996 and remains at roughly 2% afterwards, whereas it remains stable at 1% for the continuously insured elderly throughout this

[29] Betel-nut chewing is found to be associated with mouth cancer by the medical profession.

period. This suggests that NHI seems to have removed the financial barrier to visiting doctors for some of the previously uninsured elderly.

In the following three panels, we observe a similar pattern across outpatient visits, hospitalizations and ER visits. In 1993, the then-uninsured elderly have a much lower probability of utilization than the insured elderly. However, in 1996, the probability of utilization for the previously uninsured elderly rises dramatically. For example, the probability of outpatient visits increases by 26 percentage points, the probability of hospitalizations by 10 percentage points and ER visits by 4 percentage points for the previously uninsured elderly. On the other hand, the changes for the continuously insured elderly are not as dramatic as the previously uninsured elderly. Furthermore, the increase in 1996 brings the previously uninsured elderly to par with their continuously insured counterparts afterwards.

In contrast to probability of a visit, the two elderly groups have very similar numbers of positive visits conditional on having at least one visit across years (column (3) and (4)), suggesting that NHI affects the extensive margin but not the intensive margin of utilization.

Sample Attrition Problem

Table 3 obviously shows that our sample depletes across years. The sample attrition is mostly resulted from death and could possibly bias our DD estimation of the NHI effect on utilization if the attrition is not random. For example, if the deceased elderly are more likely to be high users than their living counterparts, then the DD method with an unbalanced panel tends to underestimate the NHI effect on utilization. We verify this by comparing utilization in 1993 of those who only appeared in the 1993 survey with that of those who appeared in 1993 and later

surveys. We find that the former actually had higher utilization in 1993 than the latter. To reduce this possible attrition bias, we use balanced panels in all our regressions.

Yearly Mortality Rate

To get a general picture of the crude mortality, we use the yearly mortality rate defined as deaths occurred during a 12-month period divided by those alive in the beginning of that period. To correspond to the implementation date of NHI, each period begins in March and ends in February. Figure 2 plots the yearly mortality rates for the two elderly groups from March 1993 to February 2003 using the survey's collection of death records and the DOH mortality data.

As shown, whereas the yearly mortality rate of the continuously insured elderly rises steadily from 3% in 1993 to 4.5% in 1996, that of the previously uninsured elderly first rises from 5% in 1993 to 7% in 1994 and then quickly declines to 6% in 1995 and to 4.7% in 1996. After 1996, the two groups basically merge and move together until 1999 when they start to oscillate up and down again. However, the mortality gaps between the two groups after 1999 are never as big as in the pre-NHI period. At first glance, the pattern in yearly mortality rate seems to be associated with the pattern in utilization.

5. Estimation Results

NHI Effect on Utilization

Estimation results of NHI effects on probabilities are reported in Table 4.[30] Note that model 1 is the model stated in equation (1) using three separate panels pooled across only a pair

[30] We also estimate NHI effect on numbers of visits conditional on having at least one visit. However, we do not find any significant evidence and the results are thus not reported.

of years and model 2 is the pooling model stated in equation (2) using a panel pooled across all four years. In general, the results show that NHI removes the financial barrier and largely increases utilization for the previously uninsured elderly relative to their continuously insured counterparts. More precisely, in panel A (1993 versus 1996), model 1 results show that NHI decreases the probability of foregoing doctor visits by 4 percentage points, increases the probability of outpatient visits by 13 percentage points and the probability of hospitalizations by 9 percentage points for the previously uninsured elderly relative to their continuously insured counterparts; and these results are statistically significant. In contrast, we only find an insignificant 1.7-percentage-point change in their probability of ER visits.

Model 1 results in panel B (1993 versus 1999) and C (1993 versus 2003) are basically similar to panel A except for that there is a significant 5 percentage-point increase and an insignificant 3.4 percentage-point increase in the probability of ER visits in the panel B and C respectively. This finding suggests that the NHI effect on utilization was realized soon after the NHI was implemented.

Model 2 results are different from model 1 results in the case of hospitalizations and ER visits. In particular, NHI effects in 1996 and 1999 estimated by model 2 are smaller than those estimated by model 1. Recall that model 2 uses only the elderly who appeared in all four years, while model 1 only requires the elderly to appear in two years. This finding suggests that differences in NHI effects are likely resulted by attrition due to death.

Subgroup Analysis of Utilization

Since the previously uninsured elderly and their continuously insured counterparts were different in many aspects in their baseline characteristics, e.g. age, gender, ethnicity, health, etc., it is interesting to see if the NHI effects also differ among subgroups. Especially, one would expect sick elderly, e.g. elderly with chronic conditions, would have benefited more from NHI than healthy elderly.

Panel A in Table 5 shows that the relatively younger uninsured elderly (aged 64-73 in 1993) benefit from NHI more than the very old uninsured elderly (aged 74 and older in 1993) in terms of foregoing doctor visits and outpatient visits, but the very old uninsured benefit more in hospitalizations and ER visits. In panel B, uninsured women tend to benefit more than uninsured men except for outpatients visits. In panel C, uninsured non-Minnan people seem to benefit more than uninsured Minnan people.

As for chronic conditions, in our sample, diabetes (10%), hypertension (30%) and heart diseases (21%) are the three most prevalent chronic conditions among the elderly. These three conditions typically require constant medical attention and medications. We thus compare people with these conditions to those with no chronic conditions. We find that (in panel D) uninsured elderly with these chronic conditions experienced larger increases in utilization than those without chronic conditions.

NHI Effect on Mortality Hazard

In Table 6, the top panel reports the original estimates of coefficients in equation (5), while the bottom panel reports pre- and post-NHI hazard ratios based on the estimated coefficients. Columns (1) to (3) use the survey's collection and column (4) to (6) use the DOH

mortality data. Column (1) and (4) do not control for pre-NHI characteristics; column (2) and (5) control for pre-NHI demographic and economic variables; column (3) and (6) further control for pre-NHI health variables. The more controls we add in, the more conservative the estimates become.

Our main interest lies in the interaction term *UI*×*POST*, which represents the difference in differences in log hazards between the two groups across the pre and post-NHI periods. The results show that the DD in log hazards range from -0.334 to -0.248, which implies the log hazard of the previously uninsured elderly decreased in the post-NHI period relative to their continuously insured counterparts. The more controls we add, the smaller the absolute values of the DD estimates. However, they are all significant at least at the 10% level.

To get more comprehensible interpretations, it is helpful to look at the hazard ratios at the bottom panel in Table 6. In general, pre-NHI hazard ratios are all well above one and post-NHI hazard ratios are close to one. More precisely, the hazard ratio is about 1.3 in the pre-NHI period, indicating the risk of dying of the then-uninsured elderly is about 30% higher than that of the insured elderly. It then drops to one in the post-NHI period, implying the risk of dying for the two elderly groups merge together after NHI has been implemented.

Instead of dichotomously cutting time into the pre and post period, we modify equation (5) by estimating two alternative models. Model 1 includes a full set of year dummies but remains one interaction term of *UI*×*POST*. Model 2 include a full set of year dummies and interaction terms of year dummies and *UI*.[31] In Table 7, the interaction terms of *UI*×*POST* in model 1are actually similar to the results in Table 6. On the other hand, the interaction terms in

[31] All regressions still include a full set of pre-NHI controls.

model 2 show that the NHI effect on mortality gradually increased from 1996 and reached its peak in 1999 and then decreased towards the end.

Subgroup Analysis of Mortality Hazard

We also find that NHI effect on mortality hazard differs across subgroups. As shown in the top panel in Table 8, NHI has a larger effect on the relatively younger uninsured elderly, women and non-Minnan people, compared to the very old uninsured elderly, men and Minnan people, respectively. In the bottom panel, NHI has a much larger effect on the uninsured elderly with diabetes or hypertension than those without chronic conditions. However, we do not find an NHI effect on elderly with heart diseases, although we previously find that NHI increased their utilization. This may suggest that elderly with heart diseases were so ill that medical care could not save their lives.

Suggestive Evidence of the Validity of the First DD Assumption

Panel A in Table 9 reports *F* statistics and *p*-values to test the null hypothesis: $\beta_8 = \beta_9 = \beta_{10} = \beta_{11} = 0$ in equation (2). In general, the results do not reject the null hypothesis except for two cases.[32] This suggests that in general NHI had minimal impact on utilization for the continuously insured elderly.

We also modify equation (4) by including 4 insurance dummy variables indicating GEI, LI, VI and OL and interaction terms of these dummies with the *POST* dummy. Then we test the same hypothesis. As show in panel B, we do not reject the null hypothesis, which implies that our first DD assumption is also valid for the mortality hazard model.

[32] Outpatient visits in the case of 1993 versus 1999 and 1993 versus 2003.

6. Conclusion

One common argument of providing universal insurance coverage to people is that insurance will improve people's health by giving them access to medical care and increasing their utilization. This paper finds that Taiwan's NHI removed the financial barrier for the previously uninsured elderly and largely increased their utilization relative to the continuously insured elderly. Corresponding to the increase in utilization, the mortality hazard ratio of the previously uninsured elderly to the continuously insured elderly dropped from 1.3 in the pre-NHI period to close to one in the post-NHI period. Our findings suggest that NHI improved the health of the previously uninsured elderly through health care.

Our subgroup analyses provide a closer look at the NHI effects. We find that the NHI effects differ across age, sex, ethnicity and health groups. This reflects both the differential needs of medical care across groups and the differential effectiveness of care in serving different medical needs. While we find that the elderly with a larger increase in medical care utilization—due to NHI—generally also experienced a larger decline in their mortality hazard, this is not always the case. For example, we find that NHI increased utilization for the elderly with diabetes and hypertensions and also lowered their mortality hazard than those without chronic conditions, suggesting medical care is effective in improving health. In another case, however, we find NHI increased utilization for the elderly with heart diseases but did not lower their mortality hazard, suggesting medical care is not effective in this case. Therefore, whether and how much insurance can improve people's health still depends on the need and effectiveness of medical care.

While several previous studies had investigated Taiwan's NHI effects, the major contribution of this chapter is the finding of the NHI effect on mortality, which is different from

the conclusion of Chen et al. (2007). As we mentioned in various places in the main text and Appendix 2, the difference between our findings can be attributed to several reasons. One of the main possible reasons is that Chen et al. did not fully utilize the mortality data and, even worse, may have mishandled the data.

REFERENCES

Card, D., C. Dobkin and N. Maestas (2004). "The Impact of Nearly Universal Insurance Coverage on Health Care Utilization and Health: Evidence from Medicare." Working paper #10365, *National Bureau of Economic Research*.

Chen, L., W. Yip, M. C. Chang, H. S. Lin, S. D. Lee, Y. L. Chiu and Y. H. Lin (2007). "The Effects of Taiwan's National Health Insurance on Access and Health Status of the Elderly." *Health Economics*, 16: 223-242.

Cheng, T. M. (2003). "Taiwan's New National Health Insurance Program: Genesis and Experience So Far." *Health Affairs*, 22: 61-76.

Cheng, S. H., and T. L. Chiang (1997). "The Effect of Universal Health Insurance on Health Care Utilization in Taiwan: Results from a Natural Experiment." *Journal of the American Medicine Association*, 278: 89-93.

---------(1998). "Disparity of Medical Care utilization among Different health Insurance Schemes in Taiwan." *Social Science and Medicine*, 47: 613-620.

Chiang, T. L. (1997). "Taiwan's 1995 Health Care Reform." *Health Policy*, 39: 225-239.

Currie, J., and J. Gruber (1996a). "Health Insurance Eligibility, Utilization of Medical Care and Child Health." *Quarterly Journal of Economics* CXI: 432-466.

---------(1996b). "Saving Babies: The Efficacy and Cost of Recent Changes in the Medicaid Eligibility of Pregnant Women." *Journal of Political Economy*, 104: 1263-1296.

---------(1997). "The Technology of Birth: Health Insurance, Medical Interventions and infant Health." Working paper #5985, *National Bureau of Economic Research*.

Haas, J. S., S. Udvarhelyi, and A. M. Epstein (1993a). " The Effect of Providing Health Coverage to Poor Uninsured Pregnant Women in Massachusetts." *Journal of the American Medical Association*, 269: 87-91.

---------(1993b). "The Effect of Health Coverage for Uninsured Pregnant Women on Maternal Health and the Use of Cesarean Section." *Journal of the American Medical Association*, 270: 61-64.

Hanratty, M. (1996). "Canadian National Health Insurance and Infant Health." *The American Economic Review*, 86: 276-284.

Hsueh, Y. S., S. Y. Lee and Y. T. Huang (2004). "Effects of Global Budgeting on the Distribution of Dentists and use of Dental Care in Taiwan." *Health Services Research*, 39: 2135-2153.

Lee, M. C., and A. M. Jones (2004). "How Did Dentists Respond to the Introduction of Global Budgets in Taiwan? An Evaluation Using Individual Panel Data." *International Journal of Health Care Finance and Economics*, 4: 307-326.

Levy, H., and D. Meltzer (2004). "What Do We Really Know about Whether Health Insurances Affects Health?" in *Health Policy and the Uninsured: Setting the Agenda*, Catherine McLaughlin (ed.), Urban Institute Press: Washington DC.

Lichtenberg, F. R. (2002). "The Effects of Medicare on Health Care Utilization and Outcomes." *Frontiers in Health Policy Research*, 5: Article 3.

Liu, T. C., and C. S. Chen (2002). "An Analysis of Private Health Insurance Purchasing Decisions with National Health Insurance in Taiwan." *Social Science and Medicine*, 55: 755-74.

Peabody, J. W., J. C. Yu, Y. R. Wang, and S. R. Bickel (1995). "Health System Reform in the Republic of China: Formulating Policy in a Market-Based Health System." *Journal of the American Medical Association*, 273: 777-781.

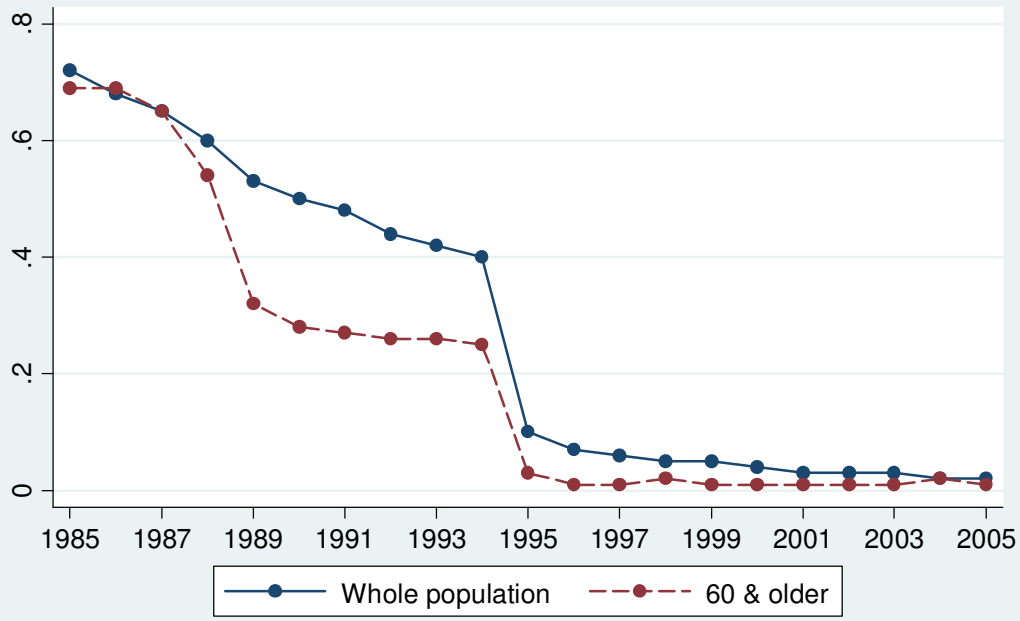
Polsky, D., J. A. Doshi, J. Escarce, W. Manning, S. M. Paddock, L. Cen and J. Rogowski (2006). "The Health Effects of Medicare for the Near-Elderly Uninsured." Working paper #12511, *National Bureau of Economic Research*.

Wen, C. P., S. P. Tsai and W. S. Chung (2008). "A 10-Year Experience with Universal Health Insurance in Taiwan: Measuring Changes in Health and Health Disparity." *Annals of Internal Medicine*, 148: 258-267.

Zimmer, Z., L. G. Martin and M. C. Chang (2002). "Changes in Functional Limitation and Survival among Older Taiwanese, 1993, 1996, and 1999." *Population Studies*, 56: 265-276.

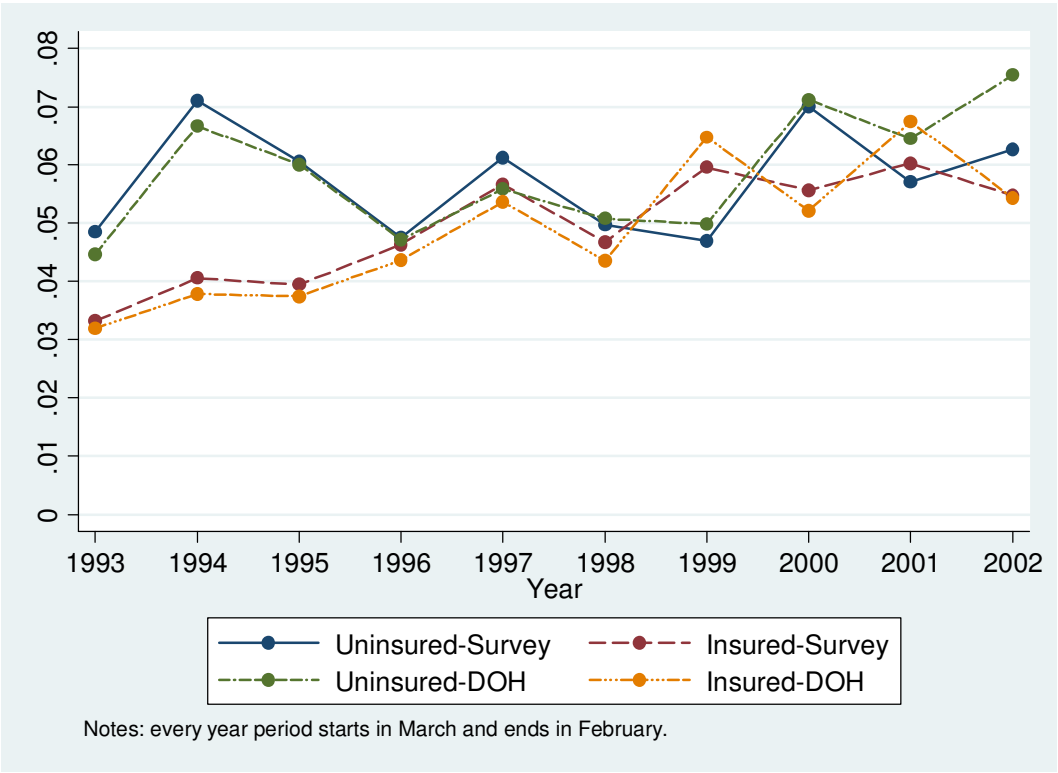
Zimmer, Z., L. G. Martin and H. S. Lin (2005). "Determinants of Old-age Mortality in Taiwan." *Social Science and Medicine*, 60: 457-70.

Figure 1. Uninsurance Rate: 1985-2005



Notes: the uninsured before 1995 refers to people who were not covered by GEI, LI, FHI and VI; the uninsured starting in 1995 refers to people who were not enrolled in NHI.
Sources: Bureau of Central Trust; Bureau of Labor Insurance; Bureau of National Health Insurance; Veteran Affairs Commission; Ministry of Interior. See text for more about sources.

Figure 2. Yearly Mortality: 1993-2002



Notes: every year period starts in March and ends in February.

Table 1. Elderly Insurance Status in 1993

	n	%
Government Employee Insurance Programs (GEI)	483	15.40
Labor Insurance (LI)	164	5.23
Farmer's Health Insurance (FHI)	1,227	39.13
Veteran Insurance Programs (VI)	391	12.47
Other Insurance Programs (OI)	86	2.74
Uninsured	785	25.03
Total	3,136	100.00

Notes: GEI includes Government Employee Insurance, Government Retiree Insurance, Government Employee's Dependents Insurance and Government Retiree's Dependents Insurance. VI includes Veteran Insurance and Veteran's Dependents Insurance. OI includes Councilor Insurance, Welfare Insurance, Fishermen Insurance, Military Insurance, Military Personnel's Dependents Insurance.

Table 2. Characteristics of the Elderly in 1993

	Insured	Uninsured
Age (mean)	71	72
Female (%)	39	57
Married with spouse present (%)	67	47
Ethnicity (%)		
Minnan	56	74
Hakka	17	10
Mainlander	24	14
Aboriginal	2	1
Region (%)		
East	9	6
North	23	38
Central	36	29
South	32	26
Urban area (%)	59	77
Live with adult children (%)	64	70
Years of education (%)		
0 Year	45	60
1-6 Years	33	31
7 Years and more	22	9
Currently employed/ self-employed (%)	23	11
Monthly income > NT$10,000 (%)	45	31
Ever worked as (%)		
Farmer	51	26
Government employee	15	5
Military personnel	21	6
Self-reported health (%)		
Very good/ good	41	36
Fair	33	31
Bad/ very bad	21	24
No response	5	9
Functional limitation (ADL) (mean)	0.38	0.54
Have one or more chronic condition(s) (%)	75	74
One Year Mortality (%)	3.3	4.8
Health behavior (%)		
Smoking	29	27
Drinking	13	13
Betel nut chewing	6	4
Total	2,351	785

Notes: ADL is an average score of 12 functional limitation items of daily activities. Each item ranges from 0 (no difficulty) to 3 (cannot do it at all). Chronic conditions include arthritis, asthma, cancer, cataract, diabetes, hypertension, heart problem, kidney problem, liver problem, stroke, and ulcer. Mortality is based on survey's collection.

Table 3. Summary of Utilization

	Probability				Average Positive Visits			
	(1) Insured		(2) Uninsured		(3) Insured		(4) Uninsured	
Forego Visits								
1993	0.01	(2,351)	0.06	(785)				
1996	0.01	(1,928)	0.02	(584)				
1999	0.01	(1,649)	0.03	(503)				
2003	0.01	(1,249)	0.02	(362)				
Outpatient Visits								
1993	0.50	(2,347)	0.34	(784)	2.9	(1,153)	2.8	(261)
1996	0.63	(1,926)	0.60	(583)	2.6	(1,052)	2.6	(286)
1999	0.71	(1,648)	0.63	(503)	3.1	(1,154)	3.0	(312)
2003	0.74	(1,248)	0.70	(361)	2.4	(923)	2.3	(252)
Hospitalizations								
1993	0.20	(2,351)	0.10	(785)	1.4	(463)	1.2	(79)
1996	0.22	(1,928)	0.20	(584)	1.6	(419)	1.3	(114)
1999	0.24	(1,649)	0.23	(502)	1.6	(391)	1.6	(116)
2003	0.20	(1,249)	0.24	(362)	1.8	(254)	1.4	(86)
ER Visits								
1993	0.11	(2,351)	0.07	(783)	1.4	(240)	1.2	(52)
1996	0.13	(1,928)	0.11	(584)	1.9	(254)	1.9	(64)
1999	0.15	(1,637)	0.15	(502)	1.8	(245)	1.7	(76)
2003	0.18	(1,249)	0.17	(362)	1.7	(225)	1.7	(62)

Notes: observations in parentheses; majority of non-responses (over 70%) is due to death; percentages of non-responses due to death are roughly equal between insured and uninsured; about 9% of the insured and 11% of the uninsured respondents in 1996 fail to recall their exact number of outpatient visits; for other years and visits, percentages of failed recalls are less than 2%.

Table 4. NHI Effect on Probability of Utilization

Forego Visits		*Outpatient Visits*		*Hospitalizations*		*ER Visits*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
			A: 1993 versus 1996				
-0.041	-0.043	0.131	0.143	0.093	0.042	0.017	0.000
(-3.66)	(-2.79)	(4.51)	(3.68)	(4.18)	(1.62)	(0.9)	(0.02)
[2,512]	[1,469]	[2,504]	[1,463]	[2,512]	[1,469]	[2,510]	[1,458]
			B: 1993 versus 1999				
-0.032	-0.038	0.09	0.09	0.095	0.062	0.049	0.036
(-2.74)	(-2.58)	(2.88)	(2.37)	(3.75)	(2.15)	(2.27)	(1.48)
[2,152]	[1,469]	[2,148]	[1,463]	[2,151]	[1,469]	[2,137]	[1,458]
			C: 1993 versus 2003				
-0.046	-0.043	0.117	0.11	0.126	0.139	0.034	0.045
(-3.32)	(-2.95)	(3.21)	(2.88)	(4.20)	(1.62)	(1.33)	(1.64)
[1,611]	[1,469]	[1,607]	[1,463]	[1,611]	[1,469]	[1,609]	[1,458]

Notes: dependent variables are dummy variables indicating each type of utilization; only the interaction terms are reported; all pooled panels are restricted to balanced panels; model 1 only pools a pair of years; model 2 pools all 4 years; cluster-robust *t* in parentheses; subjects in brackets; all regressions include pre-NHI demographic, economic and health controls.

Table 5. NHI Effect on Probability of Utilization By Subgroups

Forego Visits		*Outpatient Visits*		*Hospitalizations*		*ER Visits*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A: By Age in 1993							
64 to 73	74+	64 to 73	74+	64 to 73	74+	64 to 73	74+
-0.052	-0.018	0.159	0.074	0.066	0.152	-0.012	0.068
(-3.72)	(-0.94)	(4.54)	(1.39)	(2.54)	(3.45)	(-0.65)	(1.68)
[1,838]	[674]	[1,832]	[672]	[1,838]	[674]	[1,836]	[674]
B: By Sex							
Female	Male	Female	Male	Female	Male	Female	Male
-0.057	-0.021	0.119	0.146	0.099	0.089	0.034	-0.000
(-3.43)	(-1.47)	(2.84)	(3.57)	(3.21)	(2.71)	(1.28)	(-0.02)
[1,109]	[1,403]	[1,106]	[1,398]	[1,109]	[1,403]	[1,107]	[1,403]
C: By Ethnicity							
Minnan	Non-Minan	Minnan	Non-Minan	Minnan	Non-Minan	Minnan	Non-Minan
-0.041	-0.042	0.121	0.142	0.085	0.106	0.019	-0.002
(-2.95)	(-2.48)	(3.44)	(2.66)	(3.17)	(2.46)	(0.85)	(-0.05)
[1,540]	[972]	[1,534]	[970]	[1,540]	[972]	[1,539]	[971]
D: By Chronic Conditions							
Diabetes	Heart Disease	Diabetes	Heart Disease	Diabetes	Heart Disease	Diabetes	Heart Disease
-0.023	-0.068	0.210	0.074	0.086	0.2	-0.043	0.11
(-0.85)	(-2.49)	(2.33)	(1.11)	(1.01)	(3.53)	(-0.69)	(2.26)
[236]	[503]	[235]	[502]	[236]	[503]	[235]	[520]
Hypertension	No	Hypertension	No	Hypertension	No	Hypertension	No
-0.060	-0.022	0.106	0.092	0.111	0.06	-0.013	-0.022
(-3.14)	(-1.36)	(1.93)	(1.7)	(2.28)	(1.68)	(-0.32)	(-0.83)
[754]	[338]	[751]	[337]	[754]	[338]	[753]	[338]

Notes: cluster-robust *t* statistics in parentheses; subjects in brackets; results are from model 1 using 1993 versus 1996 pooled panel; all regressions include pre-NHI controls except for the variable of interest in each subgroup comparison.

Table 6. NHI Effect on Mortality Hazard

Data Source	Survey			DOH		
	(1)	(2)	(3)	(4)	(5)	(6)
UI	0.449	0.311	0.246	0.447	0.321	0.273
	(3.48)	(2.34)	(1.84)	(3.37)	(2.36)	(1.99)
POST	0.307	0.438	0.55	0.381	0.492	0.576
	(3.71)	(5.26)	(6.56)	(4.49)	(5.79)	(6.75)
UI×POST	-0.334	-0.318	-0.268	-0.293	-0.282	-0.248
	(-2.29)	(-2.17)	(-1.83)	(-1.97)	(-1.89)	(-1.66)
Pre-NHI controls:						
Demographic & Economic	No	Yes	Yes	No	Yes	Yes
Health	No	No	Yes	No	No	Yes
Subjects	3,136	3,136	3,136	3,136	3,136	3,136
Deaths	1,367	1,367	1,367	1,389	1,389	1,389
Hazard Ratio:						
Pre-NHI	1.57	1.36	1.28	1.56	1.38	1.31
Post-NHI	1.12	0.99	0.98	1.17	1.04	1.03

Notes: *t* statistics are in parentheses; POST is an indicator for period after March 1995 when NHI was implemented; hazard ratio is calculated as exp(UI) in the pre-NHI period and exp(UI+UI×POST) in the post-NHI period.

Table 7. Alternative Mortality Hazard Models

	Survey		DOH	
	(1)	(2)	(3)	(4)
	Model 1	Model 2	Model 1	Model 2
UI	0.24	0.24	0.27	0.27
	(1.8)	(1.8)	(1.96)	(1.96)
UI×POST	-0.26		-0.24	
	(-1.77)		(-1.61)	
UI×1995		0.06		0.08
		(0.26)		(0.33)
UI×1996		-0.29		-0.25
		(-1.17)		(-1.00)
UI×1997		-0.33		-0.39
		(-1.46)		(-1.67)
UI×1998		-0.31		-0.27
		(-1.24)		(-1.06)
UI×1999		-0.58		-0.60
		(-2.33)		(-2.42)
UI×2000		-0.13		-0.12
		(-0.55)		(-0.50)
UI×2001		-0.42		-0.39
		(-1.64)		(-1.64)
UI×2002		-0.31		-0.21
		(-1.21)		(-0.83)
UI×2003		0.00		0.04
		(0.00)		(0.16)
Subjects	3,136	3,136	3,136	3,136
Deaths	1,367	1,367	1,389	1,389

Notes: all regressions include a full set of year dummies; model 1 includes one interaction term of UI and POST, which indicates the entire post-NHI period; model 2 includes a full set of interaction terms of UI and year dummies; a full set of pre-NHI controls are included; estimates of year dummies are not reported.

Table 8. NHI Effect on Mortality Hazard by Subgroups

	A: By Age in 1993		B: By Sex		C: By Ethnicity	
	64 to 73	74+	Female	Male	Minnan	Non-Minnan
UI	0.334	0.215	0.422	0.027	0.104	0.591
	(1.62)	(1.23)	(2.16)	(0.14)	(0.63)	(2.55)
POST	0.621	0.494	0.597	0.537	0.571	0.57
	(5.02)	(4.31)	(4.14)	(5.2)	(5.22)	(4.35)
UI×POST	-0.422	-0.169	-0.5	-0.008	-0.191	-0.587
	(-1.88)	(-0.87)	(-2.32)	(-0.04)	(-1.07)	(-2.21)
Hazard Ratio:						
Pre-NHI	1.4	1.24	1.52	1.03	1.11	1.81
Post-NHI	0.92	1.05	0.92	1.02	0.92	1
Subjects	2,183	953	1,365	1,771	1,901	1,235
Deaths	710	657	542	825	874	493

	D: By Chronic conditions			
	Diabetes	Hypertension	Heart Diseases	No chronic condition
UI	0.438	0.602	-0.18	0.418
	(1.43)	(2.51)	(-0.67)	(1.26)
POST	0.603	0.904	0.226	0.757
	(2.86)	(5.6)	(1.48)	(3.46)
UI×POST	-0.599	-0.734	0.165	-0.334
	(-1.7)	(-2.8)	(0.56)	(-0.95)
Hazard Ratio:				
Pre-NHI	1.55	1.83	0.836	1.52
Post-NHI	0.85	0.87	0.986	1.09
Subjects	328	946	669	790
Deaths	197	435	329	276

Notes: *t* statistics in parentheses; all regressions include pre-NHI controls except for the variable of interest in each subgroup comparison. Use survey data. Results using DOH data are similar but not reported.

Table 9. Validity Test of The First DD Assumption

A: Utilization			
Forego	*Outpatient*	*Hospitalization*	*ER*
(1)	(2)	(3)	(4)
1993 versus 1996			
1.16	1.2	0.96	1.7
(0.33)	(0.31)	(0.43)	(0.15)
1993 versus 1999			
1.4	2.51	1.01	0.52
(0.23)	(0.05)	(0.4)	(0.72)
1993 versus 2003			
1.77	3.13	1.06	0.63
(0.13)	(0.01)	(0.37)	(0.64)
B: Mortality Hazard			
	Survey	DOH	
	1.16	0.88	
	(0.89)	(0.93)	

Notes: *F* statistics and *p*-values (in parentheses) are reported; FHI is the reference group; all regressions include pre-NHI demographic, economic and health controls.

Appendix 1: Insurance Status in 1993 and Survey Questions

Insurance status in 1993

In the 1993 survey, the elderly respondents are first asked if they are insured. If yes, they are further asked what kind of insurance they have. In the second question, there are 15 insurance programs of which 14 are social insurance programs and 1 is private insurance. In the raw data, 787 report uninsured, 2,367 insured and 1 unknown. However, among the 787 uninsured, 4 report being insured by some insurance program in the following question. To check these conflicts, I use another question asking them who paid for most of their medical expenses. If they answer health insurance paid for most of their medical expenses, they are recoded as insured. In the end, 2 are recoded and thus 785 are uninsured in 1993.

For the insured, I drop the 16 privately insured because private insurance is not comprehensive and they are likely to be affected by NHI. On the other hand, they are not completely uninsured and should not be categorized as uninsured.

In addition, I drop one case that actually died before 1993 but surprisingly appeared in the 1993 survey. I also drop another 2 insured cases without knowing their pre-NHI insurance program. Finally, there are 2,351 insured elderly who are covered by various social insurance programs.

Survey Questions about Utilization

In each wave of survey, the elderly respondents were asked a series of utilization questions in Chinese. Below are the original questions in Chinese and their English translations.

We do not use the 1989 survey because its questions are generally different from other waves of the survey.

Hospitalization

In the 1993, 1996, 1999 and 2003 survey, the elderly respondents were asked the following question regarding hospitalization.

過去一年裏，你有沒有住院過? (*In the last year, have you ever been hospitalized?*)

In the 1989 survey, however, the question was stated as:

過去半年以來，你是否曾經住過院? (包括去急診、住院觀察一天或兩天等情形) (*In the past half year, have your even been hospitalized?* (*Including visits to an emergency room, stays in a hospital for a day or two for observation.*))

ER

In 1993, 1996, 1999 and 2003 survey, the elderly respondents were asked the following question regarding emergency room visits.

在過去一年裏，你是否曾到醫院看急診? *(In the last year, have you ever visited the emergency room in a hospital?)*

There was no separate question about emergency room visits in the 1989 survey.

Western Outpatient Visits

In 1993, 1996, 1999 and 2003 survey, the elderly respondents were asked the following question regarding Western outpatient visits.

在過去一個月裏，你有沒有看過西醫?(不包括住院) (*In the last month, have you ever had western medicine visits?*(*Excluding hospitalizations.*))

This question refers to western medicine outpatient visits.

In the 1989 survey, there was no western outpatient visits question. Instead, there were questions stated as:

在過去一年裏，你是否曾經去過公立診療院所? (*In the last year, have your ever visited a public hospital or clinic?*)

在過去一年裏，你是否曾經去過私立診療院所? (*In the last year, have your ever visited a private hospital or clinic?*)

From these two questions, we do not know if the patients were hospitalized or just visited the outpatient department in a hospital or clinic.

Foregoing Doctor Visits

In 1993, 1996, 1999 and 2003 survey, the elderly respondents were asked the following questions.

最近三個月裏，你有沒有身體不舒服，想去看醫生，但卻沒去? (*In the past three months, have you ever felt ill and would like to see a doctor but eventually did not do it?*)

If one answered yes, he or she was further asked to choose from a list of reasons. One of the listed reasons was because 沒有錢 (*lack of money*). Respondents were allowed to have multiple choices.

We thus use these two questions to construct a dummy variable indicating one did not visit a doctor because lack of money. There were no such questions in the 1989 survey.

Appendix 2: Differences between this chapter and Chen et al. (2007)

Approach on Estimating NHI Effect on Mortality

As we briefly discussed before, Chen et al. use a linear DD model to estimate the NHI effect on one-year mortality. More precisely, they compare the one-year mortality rates in 1996 and 1999 to the pre-NHI rate which is an average of the 1989 and 1993 rates. In this sense, they only look at 4 annual data points and ignore information outside those years. In their Table III, their DD estimates show 1.16 and 0.42 percentage points of NHI effect on one-year mortality in 1996 and 1999 respectively, although the effects are not statistically significant. We replicate their one-year mortality rates in 1996 and 1999 and find similar rates except for one big difference: their 1999 rate for the continuously insured elderly is only about 1.87% , which is unreasonably low. We find it to be about 6% according to both the survey's collection and the DOH data.[33] See Table A1 for comparison of one year mortality rates.

In their paper, they argue that their analysis time (1989-1999) may not be long enough to detect any NHI effect on mortality. In contrast to their approach, we incorporate the DD design into a hazard model that allows us to utilize all mortality data without having to give up any piece of information we have. This approach makes a major difference even without extending the analysis beyond 1999. We can verify this by limiting the analysis time to 1993-1999 and re-estimating equation (4). The results are reported in Table A1. From 1993 to 1999, there are 901 and 875 deaths according to the survey's collection and the DOH data respectively. Even with this much shorter time period, we still find that the pre-NHI hazard ratio is about 1.3 and the

[33] It is not clear which data they use. Besides, we are not able to replicate their pre-NHI rates which should be averages of 1989 and 1993 rates, unless we know their imputation of insurance for those who appeared only in the 1989 survey.

post-NHI hazard ratio is about 1. And the pre-NHI ratio is statistically different than 1, while the post-NHI ratio is not.

Defining the Insured and Uninsured in the Pre-NHI Period

Chen et al. try to use insurance status of the elderly in 1989 and assume they remained unchanged throughout the pre-NHI period.[34] However, since there is no insurance information in the 1989 survey, they have to impute insurance status of the elderly using the following two rules: 1) for those who appeared in the 1993 survey, they assume their insurance status in 1989 is identical to 1993 status; 2) for those who appeared in the 1989 survey but did not appear in the 1993 survey, they assume those who were government employees, farmers and soldiers in 1989 were insured in 1989. In their final sample, they have 2,990 insured (called pre-NHI insurance group) and 909 uninsured (called no pre-NHI insurance group) in 1989.

However, their imputed insurance status is problematic for two main reasons. First, they assume the 1989 and 1993 insurance statuses are identical which is unlikely to be true. As we discussed in section 2, there was a series of expansions of GEI and FHI in the late 1980s and early 1990s. This implies that some elderly who were insured in 1993 could have been uninsured in 1989. We verify this by comparing the 1989 insurance information contained in the 1991 survey with the 1993 insurance status.[35] Of the 2,887 elderly whose insurance statuses in both 1989 and 1993 were available, 672 changed from uninsured to insured and 75 changed from insured to uninsured. In other words, about 26% of them changed their insurance status. This implies that the 1989 and 1993 insurance statuses of the elderly are not identical.

[34] In fact, they only use 3,899 of the initial 4,049 elderly. They are not able to assign pre-NHI insurance status to 150 elderly due to incomplete information about employment status.
[35] The 1991 survey is a telephone follow-up focusing on only health and life insurance. It has insurance history of the elderly including when they gained and stopped insurance.

Second, they assume that government employees, farmers and soldiers were insured in 1989. This assumption obviously ignores the private sector workers who might be covered by LI. In addition, only 20% of those who appeared in the 1989 survey but did not appear in the 1993 survey reported that they were working in 1989. It is thus not clear how they imputed insurance status for the other 80%.

Our sample consists of only those who appeared in the 1993 survey and is thus smaller. However, we have a more accurate demarcation between the insured and the uninsured in the pre-NHI period by using the 1993 insurance status.[36] In the context of estimating NHI effects on the previously uninsured elderly, an accurate demarcation between the treatment and control group is essential and probably more important than having a larger sample of the elderly population.

Why Our Estimates of NHI Effects on Utilization Are Similar?

Although they use the initial 1989 sample and we use the 1993 sample, we happen to have very similar estimates of NHI effects on utilization. This happens simply because there is no separation between inpatient and outpatient information in the 1989 survey and both of us use utilization information starting in 1993. As a result, those who appeared in the 1989 survey but did not appear in the 1993 survey do not enter their utilization analysis. In addition, since we both adopt DD method, our results on utilization are thus similar.

However, we still find one thing puzzling in their Table III. As indicated in note 3 in their Table III, they claim that "only the 1993, 1996 and 1999 surveys offered information on

[36] It is possible that the elderly may still change their insurance status between 1993 and 1995. However, the chance is much lower.

outpatient and inpatient care utilization." Therefore, the columns under "before NHI" in their Table III should contain only 1993 utilization information and the sample in that year. However, in the first two rows, probability of using outpatient and inpatient care, the sample size (indicated in parenthesis) of the 'No pre-NHI insurance group' (correspond to our previously uninsured) is 598 and the sample size of the 'Pre-NHI insurance group' (correspond to our continuously insured) is 2,557. These two numbers are not consistent with the data. As mentioned in Appendix 1, the original data show that there are 787 uninsured, 2367 insured and 1 with unknown status in 1993.

Table A1. Comparison of One Year Mortality Rates (%)

	Previously Uninsured Elderly		Continuously Insured Elderly	
	1996	1999	1996	1999
Chen et al. (2007)	4.85	3.08	4.38	1.87
Survey	4.75	4.69	4.63	5.95
DOH	4.71	4.98	4.36	6.47

Notes: yearly mortality rates in the first row are adopted from Table III in Chen et al. (2007); in their table, the previously uninsured were called "No Pre-NHI Insurance Group" and the continuously insured "Pre-NHI insurance group."

Table A2. NHI Effect on Hazard Ratio
Analysis Time: 1993-1999

Data	Survey			DOH		
	(1)	(2)	(3)	(4)	(5)	(6)
UI	0.449	0.304	0.241	0.447	0.315	0.257
	(3.48)	(2.25)	(1.77)	(3.37)	(2.27)	(1.84)
POST	0.26	0.346	0.451	0.288	0.363	0.451
	(2.94)	(3.91)	(5.07)	(3.19)	(4.01)	(4.96)
UI×POST	-0.33	-0.326	-0.272	-0.315	-0.313	-0.269
	(-2.09)	(-2.07)	(-1.73)	(-1.96)	(-1.95)	(-1.67)
Pre-NHI controls:						
Demographic & Economic	No	Yes	Yes	No	Yes	Yes
Health	No	No	Yes	No	No	Yes
Subjects	3,136	3,136	3,136	3,136	3,136	3,136
Deaths	901	901	901	875	875	875
Hazard Ratio:						
Pre-NHI	1.57	1.35	1.27	1.56	1.37	1.29
Post-NHI	1.13	0.98	0.97	1.14	1	0.99

Notes: *t* statistics are in parentheses; POST is an indicator for period after March 1995 to end of 1999; hazard ratio is calculated as exp(UI) in the pre-NHI period and exp(UI+UI×POST) in the post-NHI period.