

**MEDICAID CROWD-OUT OF LONG-TERM CARE INSURANCE
WITH ENDOGENOUS MEDICAID ENROLLMENT**

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ABSTRACT

With states facing tightening Medicaid budgets, the high cost of financing long-term care for the elderly through Medicaid has prompted proposals to make private long-term care insurance (LTCI) more affordable through tax incentives. The effectiveness of tax incentives for stimulating LTCI demand depends in part on the availability of Medicaid, since it is considered a substitute for LTCI. This paper examines the impact of tax subsidies and Medicaid financing on the demand for LTCI by developing and estimating a stochastic dynamic model of the decision to purchase private long-term care insurance. A key contribution of this paper is that the model also incorporates and accounts for endogenous decisions on Medicaid enrollment, nursing home use, and asset holdings, which reduces the estimate of the Medicaid crowd-out effect on LTCI demand. State-specific Medicaid enrollment criteria are explicitly accounted for in modeling the Medicaid enrollment decision. The parameters of the model are estimated using individual level data from the Health and Retirement Study for the years 1998 to 2002 by simulated maximum likelihood. Using the estimated parameters, counterfactual policy experiments are performed to investigate the effects of tax policy and Medicaid on LTCI demand. The main finding is that both effects are small. The estimated price elasticity of the LTCI demand is -0.08, implying that tax subsidies are expected to have only a limited effect in reducing the number of uninsured. Eliminating the Medicaid program increases LTCI holding by only 5.3%, implying that the demand for LTCI would remain small even without Medicaid.

1. Introduction

Due to the aging of the population, long-term care utilization is expected to increase significantly in the near future.¹ Long-term care is expensive for most of the elderly population. In 1998, the average annual cost of nursing home care was approximately \$56,000, close to the 70th percentile of the wealth distribution of single respondents aged 65 or older in the Health and Retirement Study (HRS). Despite the high long-term care cost, only a small fraction (approximately 10 percent) of the elderly population has private long-term care insurance (LTCI) to insure against long-term care shocks. Thus, many elderly individuals are exposed to the risk of asset depletion when they need long-term care, as they have to pay for this long-term care out of pocket or spend down their assets to be covered under Medicaid when they do not have private long-term care insurance.

This remarkably high long-term care expenditure is a concern to the public as well as to individuals nearing or in retirement. Long-term care spending in the United States was estimated at \$169 billion in 2005 (Kaiser Commission on Medicaid and the Uninsured (KCMU), 2007).² The major source of LTC financing is the Medicaid program. In fact, Medicaid accounted for 44% of the \$122 billion spent on nursing home expenditures in 2005. Moreover, nursing home expenditures represent the single largest category of state Medicaid expenditures. Nursing home costs account for 33% of total Medicaid expenditures (KCMU (2007)). Despite its high cost, nursing home care usage is widespread, with approximately 40% of the elderly population spending some time in a nursing home (Kemper and Murtaugh (1991)). With increasing life expectancy and the aging of the population, both the use of nursing homes by the elderly and the strain on Medicaid are expected to rise considerably.

The heavy burden on the government to finance long-term care has prompted proposals to make LTCI more affordable through tax incentives.³ The effectiveness of tax

¹Long-term care refers to services for those in need of assistance with activities of daily living (ADL), e.g. walking, eating, dressing, bathing, toileting, and getting in and out of bed. Formal long-term care can be provided in an institutional setting (as in a nursing home), at home, or in a community setting. Long-term care can also be provided informally by family members or relatives.

²The KCMU estimates are based on CMS (Center for Medicare and Medicaid Services) National Health Accounts data, 2007.

³An example is a recently introduced bill, H.R. 6237 Tax Relief for Long-Term Care Act of 2008, which amends the Internal Revenue Code to allow a tax credit for long-term care insurance premiums.

incentives for stimulating LTCI demand depends in part on the availability of Medicaid, which can be considered a substitute for LTCI. Government financing of long-term care via Medicaid may *crowd out* the market for LTCI (Pauly (1989) and Brown and Finkelstein (2008)). In addition, the impact of tax incentives also depends on price elasticity of LTCI demand, since a small price elasticity limits the effect tax subsidies can have on increasing the percentage covered by LTCI. Therefore, an assessment of policies for stimulating the LTCI market relies on both the magnitude of the Medicaid crowd-out effect and the price elasticity of LTCI demand.

My goal is to examine the impact of tax subsidies and Medicaid provisions on the demand for LTCI. I do so by developing and estimating a stochastic dynamic model of the decision to purchase private long-term care insurance. The model also incorporates decisions on Medicaid enrollment, nursing home use, and asset holdings. A key contribution of this model that has not been taken into account in earlier work is the endogeneity of the Medicaid enrollment decision, as opposed to assuming automatic enrollment in Medicaid upon meeting Medicaid eligibility criteria. The Medicaid take-up rate is far from 100% (Remler and Glied (2003)). Those who do not enroll in Medicaid though eligible may have an aversion on being on the welfare program or may not participate in it for other reasons. They may not regard Medicaid as a significant substitute for LTCI. The Medicaid crowd-out effect on LTCI demand would be lower in the presence of such individuals than in their absence.

Another innovation in my model is that savings and nursing home use are choices that individuals make. If people prefer saving more than holding private coverage in order to insure themselves against the LTC risks, the magnitude of the Medicaid crowd-out effect on LTCI demand, net of the effect on savings, would be smaller than when saving is modeled to be exogenously determined. Furthermore, if people choose not to use a nursing home in the absence of Medicaid, as opposed to buying LTCI, and thus do not demand LTCI, then the extent to which Medicaid crowds out LTCI demand would be estimated to be lower than when nursing home use is modeled to be exogenously determined.

I take state-specific Medicaid eligibility criteria into account in modeling the Medicaid enrollment decision. All states have categorically needy programs in which people are eligible for Medicaid if their income and assets fall below certain thresholds. Additionally, some states allow people to use Medicaid even if they do not meet the income and assets thresholds as long as their incurred medical care costs are sufficiently high. Under these rules, people are eligible for Medicaid if their assets and income *net of their medi-*

cal expenses are at or below certain limits. In states without such rules, people must meet the categorical thresholds in order to have access to Medicaid. These state-specific criteria serve as an important source of exogenous variation when estimating the model.⁴

In the model, elderly individuals make dynamic decisions in the face of uncertainties. In each period, they receive shocks to their health, medical care costs, income, and preference. The individuals maximize their expected life-time utility by choosing a sequence of controls (on health insurance, nursing home use, and savings) subject to budget constraints, Medicaid eligibility rules, health transition functions, and other laws of motion. The decisions are dynamic in the sense that the current choices affect the next period's state. For example, their current nursing home use affects their probability of surviving to the next period, as well as the quality of life, depending on their health status. Buying private long-term care insurance in the current period enables them to use nursing home at low cost sometime in the future. The current choice of LTCI affects the next period's LTCI premium because the schedule of the LTCI premium depends on the issuance age. Their eligibility for Medicaid is affected by their current asset levels, which are determined by previous savings decisions.

To estimate the model, I use data from the Health and Retirement Study (HRS) for the years 1998 to 2002. The HRS data provide a rich source of variables, including longitudinal information on the purchase of long-term care insurance, the duration associated with the purchase, the value of household assets, Medicaid enrollment, health outcomes, nursing home utilization, and state of residence. The latter is particularly important because Medicaid eligibility rules differ by state of residence.⁵ In addition, I make use of the reported data on the duration of the LTCI ownership for the premium function. I solve the dynamic programming decision model numerically and estimate the model parameters by the method of simulated maximum likelihood, using the model solution as an input for the likelihood function.

After recovering the structural parameters of the model, I perform three counterfactual policy experiments to estimate the magnitude of Medicaid crowd-out effects and the impact of tax policy on LTCI demand. First, I simulate the effect of removing Medicaid for the elderly. In the absence of Medicaid, the number of LTCI policy holders increases by only 5.3%. However, removing Medicaid has a larger effect on savings, increasing median

⁴Elderly individuals are assumed not to move across states in this paper.

⁵The state-of-residence variable is a restricted part of the HRS.

assets by 15.3%. Additionally, without Medicaid, people would tend to decrease nursing home use. Second, I simulate the effect of various degrees of preference towards Medicaid on LTCI holding. If individuals with negative Medicaid preference were to have the same Medicaid preference as that of those with positive preference, so that all who qualify for Medicaid are enrolled in it, fewer people are estimated to choose LTCI. This experiment implies that under the assumption of automatic Medicaid enrollment decisions, the Medicaid crowd-out effect on LTCI demand is overestimated. Third, I simulate how many more people would buy LTCI in response to a reduction in premiums. The estimated price elasticity of LTCI demand is -0.08. Thus, tax policies affecting LTCI premiums would only have a limited effect on reducing the number of uninsured.

The rest of the paper is organized as follows. In Section 2, previous literature is examined. In Section 3, the institutional background is explained. In Section 4 and 5, I present the model and the solution method, respectively. The data are described in Section 6. Estimation methodology, results, and model fits are discussed in Section 7 and policy experiments in Section 8. Section 9 concludes.

2. Previous Literature

Of the literature that deals with the topic of Medicaid, long-term care, and private long-term care insurance, the issues examined by Pauly (1989, 1990), Brown and Finkelstein (2008), Brown, Coe, and Finkelstein (2006), Hubbard, Zeldes, and Skinner (1994, 1995), and Gardner and Gilleskie (2007) are the closest to those studied in this paper.⁶ Pauly (1989) theoretically shows that Medicaid has the potential to considerably reduce the demand for LTCI even among the non-poor.

Building on the insight of a Medicaid crowd-out effect among even non-poor population, Brown and Finkelstein (2008) quantify the magnitude of Medicaid crowd-out effects by developing a utility-based model and calculating the willingness to pay for a private insurance contract. They show that the willingness to pay for the LTCI is smaller than the actual LTCI premium at the 70th (60th) percentile of wealth distribution for men (women) and attribute the lack of private insurance purchases to the implicit tax of Medicaid on

⁶This literature includes Finkelstein and McGarry (2005), Finkelstein, McGarry, and Sufi (2005), Sloan and Norton (1997), Norton (2000), Mellor (2000), Murtaugh, Kemper, Spillman, and Carlson (1997), Courtemanche and He (2009), Cohen and Weinrobe (2000), Goda (2009), Wiener, Illston, and Hanley (1994), and Wiener, Tilly, and Goldenson (2000).

LTCI. The implicit tax refers to *redundant* benefits provided by private insurance that Medicaid would have provided had the individual not purchased private insurance. Brown, Coe, and Finkelstein (2006) provide empirical evidence of the Medicaid crowd-out of LTCI demand, using the variation across individuals in the amount of assets that can be protected from Medicaid. They find that changes in Medicaid's asset thresholds are unlikely to have a substantial effect on LTCI and argue that changes in Medicaid's asset limits do not have a large impact on the implicit tax. However, neither of these two studies investigates the impact of eliminating the implicit tax on the Medicaid crowd-out on LTCI. In my paper, I examine how people would behave in the absence of the implicit tax by estimating the effect of eliminating the Medicaid program, which removes such a tax.

In Brown and Finkelstein (2008), it is assumed that individuals automatically enroll in Medicaid once meeting eligibility criteria. However, the Medicaid take-up rate is far from 100% (Remler and Glied (2003)). Those who do not enroll in Medicaid though eligible may have an aversion to being on Medicaid or may not participate in the program for other reasons. They would prefer long-term care benefits from private sources over those from Medicaid. The presence of such people would lower the implicit tax, and hence the estimated Medicaid crowd-out effect. In my paper, I accommodate heterogeneity in preferences for Medicaid across individuals, so that, based on their preferences, individuals may choose whether or not to enroll in Medicaid if eligible for it. Furthermore, I take the dynamic aspects of the elderly individuals' LTCI holdings into consideration. Brown and Finkelstein (2008) assume that those who buy LTCI keep their insurance policy current, which is contrary to reality. The lapse rate of single elderly females of age 71 or older living in California, Florida, Texas, and Michigan from the Health and Retirement Study is as high as 25% in 2000.⁷ Additional evidence of high lapse rates besides the one from the HRS indicates that 16 percent of policies with a lifetime maximum benefit under \$100,000 lapsed in the first year (LIMRA International and the Society of Actuaries (2006)). In my model, in each period elderly individuals decide whether or not to keep the LTCI if they held it previously, or whether or not to purchase one if they did not. In addition, unlike Brown, Coe, and Finkelstein (2006), I incorporate individuals' dynamic decisions on savings, which affect their Medicaid eligibility in the next period.

Hubbard, Zeldes, and Skinner (1994, 1995) show how asset-based means testing

⁷The reasons for focusing on the single female elderly of age 71 or older, living in California, Florida, Texas, and Michigan are explained later in the data section.

of welfare programs can discourage saving by households with low expected lifetime incomes. They find such households will not accumulate wealth because saving is subject to an implicit tax rate of 100 percent in the event of an earnings downturn or medical expenses large enough to cause households to seek welfare support. By incorporating dynamic decisions on savings in my model, I examine the Medicaid crowd-out of savings as well as that of LTCI demand.

Gardner and Gilleskie (2006) evaluate the effects of changes in different Medicaid policies on the Medicaid enrollment and savings patterns of the elderly, by estimating a system of equations which are approximate decision rules of the elderly. Unlike Gardner and Gilleskie, whose research question does not involve the usage of the long-term care insurance premium structure, I explicitly model a LTCI premium function to account for LTCI pricing structure and make use of the reported data on LTCI holding duration, which is a crucial factor of the LTCI premium offered. Thus I model how one's previous period's LTCI holding affects the current period's LTCI purchase decision through the LTCI pricing structure.

3. Institutional Background

3.1. Private Long-Term Care Insurance

Private long-term care insurance (LTCI) has been available since the mid-1970s. The insurance started being aggressively sold in the mid-1980s and rapidly gained popularity recently. An LTCI policy provides payment towards the cost of long-term care services, such as nursing home or home care. The coverage provided under most LTCI policies is indemnity coverage in the traditional sense. That is, the policy makes fixed dollar payments for each unit of service obtained, regardless of the actual cost of the service. LTCI generally pays benefits only for a fixed period, with its premium increasing with the length of benefits. The benefits can be provided once benefit trigger requirements are fulfilled. For example, one must obtain the covered services and must require assistance in more than two activities of daily living (ADL) or supervision due to a cognitive impairment.⁸

LTCI is distinct from other kinds of health insurance in several ways. The vast major-

⁸Activities of daily living refer to basic tasks of everyday life, such as walking, bathing, dressing, toileting, getting in and out of bed, and eating.

ity (97%) of LTCI is sold to individuals as opposed to groups (Norton (2000)). This unique feature of LTCI helps circumvent difficulties that typically arise in the analysis of health insurance demand. In general, the decision to purchase private health insurance is closely linked with employment, as employers pay a part of insurance premiums as employee benefits. So, while factors governing policy holders' employers are usually considered in the analysis of the demand for health insurance, this is not the case for LTCI, as nearly all of the policies are sold in the individual market.

Another important feature of LTCI is associated with its premium structure. LTCI is guaranteed renewable for the lifetime of the individual at a pre-specified premium. That is, one's premium will not increase even if the policy holder's characteristics change after the LTCI purchase.⁹ However, LTCI premiums escalate rapidly with the issuance age. For example, in Florida in 2002, the average annual premiums for ages 55, 60, 65, 70, and 75 were \$865, \$1143, \$1602, \$2462, and \$3936, respectively (Johnson, Schaner, Toohey, and Uccello (2007)).¹⁰ At ages when the elderly have serious concerns about their long-term care needs, LTCI premiums might already be very high.

Using the unique pricing structure of LTCI, I apply an idea from the labor literature to my study. Since LTCI premiums are critically dependent upon the age of the policy holder at issuance, an individual may choose the price for LTCI by choosing the age at which to buy LTCI.¹¹ If an individual bought LTCI in the previous period, her LTCI premium in the current period remains the same. If not, she will face a higher premium this period than last period. Thus, previous LTCI purchase decisions affect premiums in the current period, which renders a dynamic aspect of LTCI ownership decision to the model. This aspect is in line with the labor literature, in which workers may affect their future wage offer through the accumulation of human capital, or work experience, by deciding whether to work or not in the current period. In the case of LTCI, individuals choose whether to buy the private coverage or not in the current period, and thus control their durations of LTCI

⁹An insurance company may increase its LTCI premiums if costs from long-term care claims of a certain cohort are too high for the company to keep its premiums the same. In this case, the premiums of all people in that cohort may rise. Still, a certain individual's own health deterioration does not affect his or her own premium, provided that the number of claims of his or her cohort remain stable.

¹⁰These premiums were for benefit plans that provide coverage for nursing home, assisted living facility, home health, and community-based care, with a 20-90 day elimination period, 3-6 year benefit period, \$100 daily benefit, and inflation protection.

¹¹I take the supply side of the private long-term care insurance market as given and conduct short run analyses of LTCI demand for three waves of Health and Retirement Study (HRS) data.

holding. Based on knowledge of the duration of LTCI holding and the current age of the policy holder, it is possible to calculate the future LTCI premium. In this way, individuals may affect LTCI premiums they will be offered in the future.

3.2. Medicaid

Medicaid is a public means-tested welfare program that provides health care services for those who cannot afford them. Established in 1965, it has become the largest single source of financing long-term care for either those who are low-income and have limited assets or those who have spent down their financial resources on medical and long-term care expenses. In order to qualify for Medicaid, individuals must meet eligibility criteria, which differ by state of residence. Individuals eligible for Medicaid in one state may not qualify in other states. In this section, the Medicaid criteria are explained in more detail.

The Medicaid eligibility rules, as they relate to long-term care, are generally categorized into two programs: a categorically needy program and a medically needy program. All states have a categorically needy program that specifies the limits of income and assets for Medicaid eligibility towards LTC use. The Medicaid asset threshold ranges from approximately \$1000 to \$5000, while the Medicaid income threshold ranges from \$283 to \$1482 per month in 1998 depending on the state of residence.¹² Those with income and assets at or below the respective limits are eligible for Medicaid. More specifically, an elderly individual is eligible for Medicaid if her income and assets are at or below the categorically needy income and asset limits, respectively.¹³ I denote an individual's assets at age a as W_a , her income as I_a , the Medicaid asset limit of her state of residence s as \bar{W}_s^c , and the Medicaid income limit of her state of residence s as \bar{I}_s^c . Medicaid categorical eligibility

¹²Countable assets include cash, bank accounts, CDs, stocks, mutual funds, bonds, treasury notes and treasury bills, deferred annuities, investment property, vacation homes, second vehicles, cash value of permanent life insurance policies in excess of \$1500 of face value (death benefit), and individual retirement accounts (IRAs). Countable income is generally deemed to be any recurring payment to the individual. Pensions, interest, and dividends are some examples of income.

¹³Residents whose income is greater than the state's income threshold may still apply for Medicaid through a qualified income trust, also known as a Miller trust. This trust was invented to prevent persons with as little as \$1 more than the income limit from being disqualified for Medicaid coverage. It is a legal method by which an individual can pass the monthly eligibility test for Medicaid even though his or her monthly income exceeds the Medicaid cap. Once his or her monthly income is deposited into the trust each month, the amount that has been put into the trust is then deducted from the applicant's countable income for Medicaid qualification purposes.

requirements for assets and income are

$$W_a \leq \bar{W}_s^c, \quad I_a \leq \bar{I}_s^c,$$

respectively. Additionally, some states have a medically needy program that allows people to use Medicaid even if they do not meet the categorical income and asset thresholds of their state of residence, as long as their incurred medical care costs are sufficiently high.¹⁴ Under this program, people are eligible for Medicaid if their assets and income *net of their medical expenses* are at or below certain thresholds different from the categorical ones. Suppose an individual lives in a state s with such a program and she does not qualify for Medicaid enrollment under the state's categorical criteria, namely: $W_a > \bar{W}_s^c$ or $I_a > \bar{I}_s^c$. I denote the medically needy asset threshold as \bar{W}_s^m , the medically needy income threshold as \bar{I}_s^m , and the incurred medical costs of an individual at age a that Medicare and private insurances do not cover as mc_a .¹⁵ The amount she has to spend down on medical care costs before becoming eligible for Medicaid can be written as $\max\{(W_a - \bar{W}_s^m), 0\} + \max\{(I_a - \bar{I}_s^m), 0\}$. If her incurred medical costs that Medicare and private insurances do not cover are greater than or equal to this amount, she is eligible for Medicaid. Therefore, her requirement for Medicaid eligibility is given by:

$$\max\{(W_a - \bar{W}_s^m), 0\} + \max\{(I_a - \bar{I}_s^m), 0\} \leq mc_a.$$

Besides eligibility rules, Medicaid specifies rules for the post-eligibility treatment of income. Medicaid beneficiaries who are in nursing homes should not have more income than the personal needs allowance (pna_s). Table 20 shows Medicaid assets and income limits and personal needs allowance of some states of residence.

4. Model

The model represents the decision problem of an elderly single (widowed, divorced, or never-married) woman.¹⁶ The optimization problem begins at a point in the middle of the

¹⁴States with a medically needy program have both categorically and medically needy thresholds for income and assets. The latter are usually lower than the former. Refer to Gardner and Gilleskie (2007)

¹⁵People with private insurance should use the insurance first to be eligible for Medicaid, and all who are 65 years old or older are assumed to be covered by Medicare in this paper.

¹⁶For the rest of the paper, I use *single* to refer to individual who are widowed, divorced, or never-married.

individual's life cycle. Initial conditions are those that prevail at that life cycle point. In this section, I specify the components of the model, such as the utility function, budget constraints, health transition functions, and other laws of motion.

4.1. Choice Set

At each age a , an elderly woman makes joint decisions on nursing home use, nh_a , health insurance, hi_a , and savings, sr_a . Nursing home use in this paper refers to *long-term* nursing home use (more than 100 days).¹⁷ The choice of no nursing home use includes informal care. Nursing home use can be financed by private long-term care insurance (LTCI), Medicaid, or out-of-pocket. LTCI pays for the care after a certain waiting period specified in the contract. Medicaid is available to individuals with limited income and assets who need long-term care.¹⁸ To qualify for the Medicaid program, one must meet the Medicaid eligibility requirements. If one does not meet the requirements or does not have private insurance for long-term care, one should resort to her own assets or income to pay for nursing home cost.

Considering nursing home financing methods, the elderly woman makes a health insurance choice, hi_a . This choice, as it relates to the current study, refers to *health insurance for long-term care* and can be one of the following: (1) to hold LTCI, (2) to enroll in Medicaid, or (3) to do neither. The three health insurance choices are mutually exclusive. People with private insurance should use the insurance first to be eligible for Medicaid, because Medicaid acts as a payer of last resort. The alternative of Medicaid is available only to those who meet Medicaid eligibility rules. As explained in Section 3, the eligibility for Medicaid depends on income, the level of assets (which is determined by previous savings decisions), and incurred medical care costs that Medicare and private insurances do not cover, including nursing home bills. If eligible, she decides whether to enroll in Medicaid or not. After deciding how much to save, she consumes the remainder. The choice set, D_a , is therefore:

¹⁷Medicare finances short-term nursing home use up to 100 days as a post-acute treatment after hospitalization but does not cover *long-term* nursing home use, which is of interest in this paper. As mentioned in the previous section, I assume that all elderly individuals are covered by Medicare in this paper.

¹⁸One key difference between Medicaid and LTCI is that an elderly individual may apply for Medicaid even if she was not covered by Medicaid when she incurred the long-term care expenses; however, she cannot apply for LTCI once she begins incurring the long-term care expenses.

$$D_a = \{nh_a, hi_a, sr_a\}.$$

4.2. Preferences

The preferences for consumption, private long-term care insurance (LTCI) ownership, Medicaid enrollment, and nursing home use choices are represented by the per-period utility function

$$u_a = u(C_a, hi_a, nh_a; a, H_a, k, \epsilon_a),$$

where C_a is consumption, hi_a refers to health insurance for long-term care, nh_a is nursing home use, H_a is health status, ϵ_a is the vector of shocks at age a , and k represents unobserved permanent heterogeneity across individuals in their preferences and constraints.¹⁹ A period consists of two years in accordance with the Health and Retirement Study (HRS) data interview span. In the beginning of each period, when an elderly woman turns age a , shocks to health, income, medical care costs, and preferences are realized. Upon the realization of these shocks, she makes joint decisions regarding nursing home use, health insurance, and savings to maximize her expected lifetime utility.

Individuals draw utility or disutility from consumption, health insurance ownership, and nursing home use. Consistent with prior studies, I have modeled utility from consumption as a constant relative risk aversion (CRRA) function. Buying LTCI in the current period enables nursing home use sometime in the future at low cost. Having a certain type of health insurance gives non-pecuniary benefits or costs as well as the actual insurance's benefits or premiums. The non-pecuniary benefits include peace of mind that comes from insurance ownership, private or public. Psychic costs of insurance ownership may come from going through a variety of health tests and the administration required for the application of health insurance, private or public, or from the stigma attached to Medicaid, a public welfare program.

By modeling preference on being on Medicaid, I explain the actual take-up rate of the public program. Those who do not enroll in Medicaid though eligible may have an aversion to being on Medicaid or may not participate in it for other reasons (Moffitt (1983) and Levinson and Rahardja (2004)). In the model, utility or disutility from being on Medicaid differs across health statuses. It is reasonable to expect healthier individuals to have more

¹⁹Exact functional forms are presented in the Appendix.

aversion toward Medicaid enrollment than less healthy people, because the former would have less use of benefits from Medicaid than the latter.²⁰

Preferences on LTCI holding and Medicaid enrollment are modeled to differ by permanent unobserved heterogeneity. Preferences on health insurance ownership affect the decision on its purchase (Finkelstein and McGarry (2006)). The non-pecuniary benefits of holding a certain type of health insurance may vary by type. Some individuals may draw more peace of mind than others from preparing for nursing home risks by having LTCI. Some may have lower non-monetary costs of waiting until they can actually use their LTCI policies. Medicaid aversion may vary by type as well. Some may have lower psychic costs of receiving lower quality care financed by Medicaid.

The preference on nursing home use reflects the potential enhancement in quality of life from nursing home use for those in poor health. In general, individuals in good health draw disutility from using a nursing home. However, if an individual with problems conducting activities of daily life does not receive the relevant help, her quality of life would deteriorate. For example, if she cannot get in and out of bed herself but has no one around to assist her, she will have to spend time in bed against her will. Since a nursing home is supposed to provide easy access to timely help to its residents, it is reasonable to assume that nursing home use may enhance the quality of life of those in poor health. In addition, the preference on nursing home use is modeled to be affected by age as well as health status. As people age, their resistance to nursing home use is expected to decline, since others in their age cohort use nursing homes more commonly.²¹ The psychic cost of changing one's abode when entering a nursing home is also incorporated in the per-period utility function. Besides its impact on the quality of life, nursing home use is modeled to affect the probability of surviving to the next period. This feature of nursing home use is explained in the section of health transition functions.

4.3. Budget Constraints

Budget constraints that an elderly individual faces each period are affected by the Medicaid rules of her state of residence. People on Medicaid are not allowed to retain more assets and income than Medicaid asset and income limits, respectively, and a Medicaid beneficiary

²⁰Levinson and Rahardja (2004) explain that healthier people tend to put less value on improvement of benefits that Medicaid provides.

²¹Age itself can be interpreted as an extra indicator of health of the elderly singles.

who enters a nursing home must not have income greater than the Medicaid personal needs allowance. Thus, budget constraints are specific to one's choice of Medicaid and nursing home: (1) Medicaid and no nursing home use, (2) Medicaid and nursing home use, and (3) no Medicaid.

An individual's Medicaid eligibility is determined by her state of residence, income, assets, and medical care costs in the beginning of each period and her nursing home use choice. If she is eligible for Medicaid, her budget constraints can be written as:

$$W_{a+1} = \begin{cases} (1+r)\min(W_a, \bar{W}_s) + \min(I_a, \bar{I}_s) - C_a & \text{if } hi_a = 2, \quad nh_a = 0 \quad (1) \\ (1+r)\min(W_a, \bar{W}_s) + \min(I_a, pna_s) - C_a & \text{if } hi_a = 2, \quad nh_a = 1 \quad (2) \\ (1+r)W_a + I_a - C_a - p_a \cdot I\{hi_a = 1, nh_a = 0\} & \\ -mc^{nh} \cdot I\{nh_a = 1\} + mc_a^{om} & \\ \text{if } hi_a \neq 2 & (3), \end{cases}$$

where (1) corresponds to Medicaid and no nursing home use, (2) corresponds to Medicaid and nursing home use, and (3) corresponds to no Medicaid. W_a is her asset level at age a , I_a is her income, C_a is her consumption, mc^{nh} is her nursing home costs, mc_a^{om} is her out-of-pocket costs for services other than nursing home care, p_a is her premium of LTCI if she chooses to keep or purchase LTCI, and r is the interest rate. \bar{W}_s denotes the Medicaid asset limit by which she became qualify for Medicaid, whether it was categorically needy one or medically need one, and \bar{I}_s is the corresponding Medicaid income limit, and pna_s refers to the personal needs allowance in state s .

For the choice of Medicaid and no nursing home use, the individual's assets in the next period are the minimum of her current assets and the asset limit in her state of residence plus the interest earned during the current period plus the minimum of her income and the state's income limit minus consumption. For the choice of Medicaid and nursing home use, the individual's next period's assets are the minimum of her current assets and the asset limit in her state of residence plus the interest earned during the current period plus the minimum of her income and the state's personal needs allowance minus consumption. Finally, for the choice of no-Medicaid, her next period's assets are her current period's assets plus the interest earned during the current period plus income for that period minus consumption minus medical care costs minus the premium of LTCI if she chooses to keep

or purchase LTCI.

If she does not qualify for Medicaid, or $hi_a \neq 2$, her budget constraint is

$$W_{a+1} = (1+r)W_a + I_a - C_a - p_a \cdot I\{hi_a = 1, nh_a = 0\} \\ - mc^{nh} \cdot I\{nh_a = 1\} + mc_a^{om}.$$

Note that one's nursing home costs depend on her choices of health insurance and health status. More details about nursing home costs and out-of-pocket costs for services other than nursing home are explained in the next section.

The individual also faces a borrowing constraint, namely that $W_{a+1} \geq 0$ for all a . There is assumed to be a guaranteed consumption floor \underline{C} in the model.²² The borrowing constraints prevent individuals from borrowing against the future guaranteed consumption floor.

4.4. Medical Care Costs

Medical care costs are composed of nursing home cost, mc^{nh} , and out-of-pocket costs for medical services other than nursing home, mc_a^{om} . One's medical care costs that affect her consumption is her nursing home costs, which depends on her LTC health insurance choice and on her health status, and her *out-of-pocket costs* for medical services other than nursing home, as opposed to the uninsured total medical costs for services other than nursing home. Medical care costs affect one's consumption through budget constraints. It is the out-of-pocket costs for non-nursing home services that remain even after the payments by Medicare and/or private insurances, as opposed to the total medical costs, that affect one's consumption.

Nursing home cost (mc^{nh}) depends on one's health and health insurance. Suppose an elderly woman is in poor health and did not have long-term care insurance in the previous period and are not enrolled in Medicaid in this period. Then her nursing home cost for the period is set to \$112,000, which is an approximate average annual nursing home cost times two.²³ If she has had LTCI from the previous period and is in poor health, her LTCI pays for her nursing home use. In this case, she only has to pay for the use for a certain

²²The consumption floor of \$16,196 for two years was constructed in reference to Hubbard, Skinner, and Zeldes (1994).

²³Note that one period consists of two years.

period of time, called elimination period, specified in the LTCI policy. I use 90 days for the elimination period, which is typical of LTCI policies. Therefore, she pays \$9,000 in that case. If one is on Medicaid and in poor health, her cost for using a nursing home is \$0 because Medicaid pays for the cost. If one is in good health with respect to the deficiencies in activities of daily living and uses a nursing home, no health insurance pays for her nursing home use. In this case, her nursing home cost is approximated to be half the average nursing home cost, based on the approximation of nursing home costs in different health statuses reported in the HRS. Hence, nursing home cost is given by:

$$mc^{nh} = \begin{cases} \$112,000 & \text{if } hi_a = 0, H_a = 2 \\ \$9,000 & \text{if } hi_a = 1, H_a = 2 \\ \$0 & \text{if } hi_a = 2, H_a = 2 \\ \$56,000 & \text{if } H_a = 1 \end{cases}$$

Out-of-pocket costs for medical services other than nursing home are modeled as a stochastic process of age, income, and unobserved permanent heterogeneity.²⁴ As in De Nardi, French, and Jones (2006), the out-of-pocket costs depend on income and age. In addition, it is assumed that one's permanent heterogeneity affects the costs. There is assumed to be a latent variable which determines the out-of-pocket costs for medical services other than nursing home care. I denote the latent variable by mc_a^{om*} , defined on the real line as follows:

$$mc_a^{om*} = mc^{om}(a, I_a; k, \epsilon_a^{om}).$$

In each period, a shock is drawn from a normal distribution, and the latent variable for the out-of-pocket costs for medical services other than nursing home care is realized. If the latent variable takes on a positive value, the reported medical costs for services other than nursing home is the same as the value of the latent variable. Otherwise, they are zero.

²⁴In this paper, other medical care includes in-home services. In-home services can be covered by Medicare up to 100 days under a physician's discretion. However, in the dataset of the Health and Retirement Study, the length of in-home service use is not specified. Thus, it is impossible to tell if the respondent used in-home services solely for the purpose of long-term custodial care or as an after-treatment of acute care. Therefore, I classify in-home services into the other medical care category in this paper.

4.5. Health Transition Functions

The health status is measured by the number of difficulties in performing activities of daily living (ADL). There are three health statuses: good, poor, and dead. Good health is defined as having two or fewer deficiencies in ADLs out of six, and poor health is defined as having more than two ADL problems.²⁵ $H_a = 1$ denotes good health, $H_a = 2$ poor health, and $H_a = 0$ death.

The model allows for stochastic transitions to death even before the terminal age, $A = 100$, depending on the amount invested in health in earlier periods and permanent unobserved heterogeneity, k . Thus, the probability of transitioning to death, $\pi_a^s = Pr(H_{a+1} = 0|H_a)$, is modeled to depend on nursing home use and unobserved permanent heterogeneity as well as the current health status and age, namely:

$$\pi_a^s = \pi^s(H_a, a, nh_a, k).^{26}$$

The transition probability from current health status to either good or poor health status, conditional on survival, is modeled as a function of the current health status and age. Specifically, the probability of being in good health at age $a + 1$, given the current health status at age a , H_a , and conditional on survival to age $a + 1$, is:

$$\pi_a^h = \pi^h(H_a, a).$$

Nursing home use is modeled to affect the probability of surviving to the next period. Unintentional injuries are the fifth leading cause of death in older adults (after cardiovascular, neoplastic, cerebrovascular, and pulmonary causes), and falls are responsible for two-thirds of the deaths resulting from unintentional injuries (American Geriatrics Society (2001)). If an individual in need of assistance with ADLs, e.g. walking around the room or getting in and out of bed, does not receive timely and appropriate help, she may injure herself by falling. Thus, persons with easy access to 24-hour assistance in times of need are more likely to survive to the next period than those without proper help at hand. Since a nursing home is supposed to provide timely assistance, I allow the survival probability to depend on nursing home use.

²⁵LTCI (Medicaid) usually requires policy holders (those under Medicaid) to have at least three deficiencies in ADL to provide them with nursing home benefits.

²⁶I allow for the interaction of nursing home use and age. The exact specification of health transition functions are in the Appendix.

However, nursing home use is assumed not to improve problems with ADLs themselves, because, unlike acute illnesses, individuals rarely recover from functional limitations. Therefore, I model the transition probability from current health status to a future non-death health status separately from the survival rates.

4.6. Long-Term Care Insurance Premium

The main factors that determine the LTCI premium are the initial age of the LTCI purchase and the elderly individual's health at the time of purchase. Unlike other kinds of health insurance, once the LTCI premium is determined, it does not change due to deteriorated health of the policy holder. Thus, the previous period's LTCI holding affects the current period's LTCI premium.

More specifically, in the beginning of each period, an individual is offered an LTCI premium. LTCI premium depends on the age and health at its issuance. If she had LTCI in the previous period, then the same premium is offered in the current period as the one from the previous period. If she did not have LTCI, then she is offered a LTCI premium based on her current health status and age, namely:

$$\ln p_a = \begin{cases} \ln p_{a-1} & \text{if } hi_{a-1} = 1 \\ \alpha_0 + \alpha_1 a & \text{if } hi_{a-1} \neq 1, H_a = 1 \end{cases}$$

4.7. Income Process

Income is modeled as a stochastic process of education and age:

$$I_a = I(e, a; \epsilon^i).$$

Income includes salaries, wages, earnings from self-employment, social security payments, pensions, alimony, and trust funds. Income tends to increase with education level and decrease with age. The random component explains unexpected changes in income such as receiving an inheritance. The level of education is classified into four categories: (1) elementary school or less, (2) high school dropout or less, (3) high school graduate, and (4) at least some college.

4.8. State Space

The elements of the state space, Ω_a , consist of a deterministic component and a random component. The deterministic part includes the unobserved permanent heterogeneity, k , which is known to each individual but not to researchers, as well as the component observable from the data, if not missing. The observable component is composed of the individual's state of residence, S , age, a , education, e , health status at age a , H_a , assets, W_a , previous period's health insurance choice, hi_{a-1} , duration of the LTCI ownership, dr_a , which gives information on the age of her initial LTCI purchase, and previous nursing home use choice, nh_{a-1} .

The random component of the state space is the set of shocks, ϵ_a , to income, health, out-of-pocket costs for non-nursing home care, and preference, or $\epsilon_a = \{\epsilon_a^i, \epsilon_a^h, \epsilon_a^{om}, \epsilon_a^c, \epsilon_a^l, \epsilon_a^m, \epsilon_a^n\}$, where the last four elements refer to preference shocks, i.e. to consumption, LTCI ownership, Medicaid enrollment, and nursing home use, respectively. Therefore, the state space is:

$$\Omega_a = \{S, a, e, H_a, W_a, hi_{a-1}, nh_{a-1}, dr_a; k, \epsilon_a\}.$$

5. Solution Method

Each period individuals maximize the expected discounted present value of their lifetime utility subject to budget constraints, Medicaid eligibility rules, health transition function, and other laws of motion presented in Section 4, by choosing the optimal sequence of controls, $d_a \in D_a$, conditional on states, Ω_a . The maximized expected present value of total lifetime utility is given by

$$V_a(\Omega_a) = \max_{d_a \in D_a} E\left[\sum_{a=a_0}^A \delta^{a-a_0} u_a | \Omega_a\right],$$

where δ is the discount factor and the expectation is taken over the distribution of shocks to income, health, out-of-pocket costs for non-nursing home care, and preference.²⁷ Recasting the problem in a dynamic programming framework, the value function can be written as the maximum over alternative-specific value functions, $V_a^j(\Omega_a)$, i.e., the expected discounted

²⁷ δ was set to be 0.96.

value of alternative $j \in J$ that satisfies the Bellman equation, namely

$$V_a(\Omega_a) = \max_{j \in J} V_a^j(\Omega_a),$$

$$V_a^j(\Omega_a) = \begin{cases} u_a(d_a^j | \Omega_a) + \delta E[V_{a+1}(\Omega_{a+1} | \Omega_a, d_a^j = 1)] & \text{if } a < A - 1 \\ u_a(d_a^j | \Omega_a) & \text{if } a = A - 1, \end{cases}$$

where the variable d_a^j is 1 if alternative j is chosen at age a and is 0 otherwise. The finite horizon dynamic programming model is numerically solved by backward recursion. The solution of the model consists of the values of

$$E[V_{a+1}(\Omega_{a+1} | \Omega_a, d_a^j = 1)]$$

for all j and elements of Ω_a . Treating these functions as known scalars for each value of the state space transforms the dynamic optimization problem into the static multinomial choice structure.

The solution method proceeds by backwards recursion beginning with the last decision period. For notational simplicity, the state space is partitioned into two parts, conditional on each individual's type: the set of predetermined components and the set of stochastic components. I denote the former by $\bar{\Omega}_a$. The elderly are assumed to die with certainty when they reach age $A = 100$, and thus the last decision period is the one corresponding to age $A - 1$. The value of death is normalized to 0. At age $A - 1$, the elderly draw random shocks ϵ_{A-1} from the distribution of the stochastic components of the state space and calculate the maximum terminal utility, given a particular value of the deterministic components of the state space:

$$\max_{d_{A-1} \in D_{A-1}} \{u_{A-1}(d_{A-1} | \bar{\Omega}_{A-1}, \epsilon_{A-1}, k)\}.$$

In order to calculate the expected discounted present value of lifetime utility at age $A - 2$, the expected discounted present value of maximum utility of the last decision period needs to be pre-calculated as a future component of the value function. To that end, I calculate the maximum terminal utility at any given deterministic state point, and obtain its expected value by Monte Carlo Integration. I take draws from the joint shock vector distribution and

average to obtain

$$E\left[\max_{d_{A-1} \in D_{A-1}} \{u_{A-1}(d_{A-1} | \bar{\Omega}_{A-1}, \epsilon_{A-1}, k)\}\right].^{28}$$

This expectation is calculated at all state points. I call the function the *emax* function at age $A - 1$, $\text{Emax}(A - 1)$.

Using the computed future component of the value function and the per-period utility of the period, the expected present value of lifetime utility at age $A - 2$ is obtained. This procedure is repeated at age $A - 3$, with a difference that the previously obtained expected maximum lifetime utility is used to calculate the future part of the value function at age $A - 2$, $\text{Emax}(A - 2)$. The backward recursion continues until the initial age a_0 . The set of $\text{Emax}(a)$ functions fully describes the solution to the optimization problem.

The initial age of the elderly is either 71 or 72, depending on the age they were interviewed in 1998. Because individuals in the sample are observed at a point in the middle of their life cycle, the state variables in the initial period are not exogenous and the *initial conditions problem* arises.²⁹ The assumption of serial independence in the shocks, however, implies that the state variables at any age a are exogenous with respect to decisions at a conditional on type. This initial conditions problem is solved by assuming that the sample is composed of individuals of a finite number of types and specifying the type probabilities as functions of the initial state variables.³⁰ The type probability specification can be found in the Appendix.

6. Data

The data come from Wave 4 (1998) to Wave 6 (2002) of the Health and Retirement Study (HRS). The HRS biennially obtains information from a sample of older Americans on health, insurance coverage, financial status, labor market status, and retirement planning. The HRS data provide a rich source of variables relevant to this study, including longitudinal information on the purchase of long-term care insurance, the duration associated with the purchase, the value of household assets, Medicaid enrollment, health outcomes,

²⁸The number of draws for Monte Carlo Integration is 50.

²⁹For more information on the initial conditions problem in discrete choice models, refer to Heckman (1981).

³⁰There is assumed to be a finite number of types, K . In this paper, $K = 2$.

and nursing home use. In particular, I obtain the state-of-residence variable, which is a restricted part of the HRS, and use it for the Medicaid eligibility rules, which differ by state of residence. In addition, I make use of the reported data on the duration of the LTCI ownership for the premium offer function.

I narrow my sample to single female individuals of age 71 or older in 1998 who lived in one of four states: California, Florida, Michigan, and Texas. I use single (widowed, divorced, or never-married) respondents in the analysis in order to focus on the research questions at hand while maintaining simplicity, avoiding the complexity of modeling the interaction between husband and wife and accounting for more complicated Medicaid eligibility rules for couples.³¹ Thus, I keep only those who were unmarried at the time of the interview in 1998 and remain unmarried and eliminate those who married in the following waves. I focus on women, as the majority of them were single at the time of the interview and remain unmarried from then on.

I choose the age range of 71 and above in order to avoid annuity purchase decisions and to concentrate on LTCI purchase decisions. It is possible for the elderly to annuitize their Individual Retirement Accounts (IRAs). However, a significant penalty is applied to an IRA that is not distributed by April 1st of the year following the year in which the IRA holder reaches age 70.5. In my sample, only 2% of the elderly after reaching age 70.5 annuitized their defined contribution during the period from 1998 to 2004. Thus, I assume that those who have not annuitized their defined contributions until the age of 71 keep them as assets to be withdrawn when need be, not as a future income stream.

To check the validity of focusing on single elderly women in their 70s or later regarding LTCI purchase decisions, I need to find out whether elderly single women actually chose to purchase LTCI *after* they became single if they had ever been married, and whether their purchase was made as late as in their 70s or later. If the single female elderly purchased LTCI mostly during their past marriage, their initial conditions would dominantly determine their LTCI behaviors. Also, if the majority of the elderly made the decision before the age of 71, the age range should be changed. Using the HRS data from 1998 to 2004, I find that as many as 89.7% of the formerly unmarried female respondents who had purchased LTCI during that period had bought their LTCI after they became single. Another finding is that 80.4% of them bought it in their 70s or later, which indicates that elderly sin-

³¹The model presented in this paper might be extended to include spousal decisions on LTCI purchase decisions and to account for Medicaid eligibility rules for couples.

gle female individuals in their 70s or older actively participate in LTCI purchases. Hence, my focus on single female elderly over 70 is supported by the data.

The sample is further restricted to those whose assets are no greater than \$700,000 and no less than \$0. Assets used in this paper are non-housing assets net of the value of transportation.³² I chose the four states of residence in consideration of different Medicaid rules by state of residence and of sample size. The sample in the analysis is composed of 615 persons.

Table 1 and Table 2 summarize descriptive statistics of the data. Table 1 provides a basic summary of the sample. Table 2 compares characteristics of LTCI holders and Medicaid enrollees. LTCI holders are younger than those on Medicaid. The level of assets of the former is much higher than that of the general population in the sample. LTCI holders tend to have more schooling years than Medicaid enrollees.

6.1. Choice Variables

Table 3 provide the distribution of health insurance choice (LTCI, Medicaid, or neither) and nursing home use choice by age. In their 70s, approximately 13.3% of the single female elderly had LTCI. The proportion of individuals holding LTCI decreases as they age, which is consistent with the aforementioned LTCI premium pricing structure. Medicaid enrollment increases with age. Nursing home use rises with age considerably.

In each wave of the HRS, a respondent is asked whether she has a LTCI policy not including government program and, if so, whether the policy covers both nursing home and home, nursing home only, or home care only, and how much she pays for the policy. If one reports to pay zero dollars for the policy or the policy is only for home care, the observation is excluded. If one meets these criteria, then $hi_a = 1$ for that observation. Also, in each wave a respondent is asked whether she is on Medicaid at the point of the

³²As of May 2000, countable resources exclude, but are not limited to, an individuals home, of any value, as long as it is used as the applicants principal place of residence. and the first \$4,500 in current market value of an auto. 100% of the autos value is excluded if it is equipped for use by a handicapped person, if it is needed to go to work or to perform essential daily activities due to distance, climate or terrain, or if it is used to obtain regular medical treatment (Stone (2002)). On February 8, 2006, President Bush signed into law the Deficit Reduction Act of 2005 (DRA), which cuts nearly \$40 billion over five years from Medicare, Medicaid, and other programs. Before the DRA's enactment an individual could still qualify for long-term care services even if he or she had substantial assets in his or her home. Under the DRA, states will not cover long-term care services for an individual whose home equity exceeds \$500,000, though states have the option of increasing this equity limit to \$750,000. In all states and under the DRA, the house may be kept with no equity limit if the Medicaid applicant's spouse or another dependent relative lives there.

interview. If one is reported to be on Medicaid at the point of the interview, then $hi_a = 2$ for that observation. For other observations, $hi_a = 3$, which means they neither have LTCI policy nor are enrolled in Medicaid.

A respondent is also asked whether she has ever used a nursing home in the past two years and, if so, how many nights the respondent was in a nursing home. Nursing home use, nh_a , in this paper refers to long-term use, which is defined by having used a nursing home at least 100 days in the period that age a belongs to.³³

6.2. State Variables

Table 4 provides the distribution of state variables by age. It shows the distribution of health outcomes and asset holdings by age. The percentage of those in poor health increases with age. The mean assets increase slightly at first then decrease with age.

Each wave has the information on respondents' status of activities of daily living. For example, they are asked, "We need to understand difficulties people may have with various activities because of a health or physical problem. Please tell me whether you have any difficulty doing each of the everyday activities that I read to you. Exclude any difficulties that you expect to last less than three months," and, regarding a problem with walking, they are asked, "Because of a health problem do you have any difficulty with walking across a room?". For the health measure, I use six ADL deficiencies of walking, bathing, dressing, toileting, getting in and out of bed, and eating, as is typical in the literature. For the vital

³³The choice variable of savings, sr_a , is to examine the behavior of one's assets accumulation over time, and it is constructed using the assets variable. Savings that an individual chooses at age a , sr_a , is defined by $\frac{W_{a+1}-W_a}{W_{a+1}+W_a}$, a transformation of savings rate measure, if $W_a \neq 0$. If $W_a = 0$, she chooses the difference between the assets from age $a + 1$ and the assets from age a , i.e. $W_{a+1} - W_a$. This definition for savings is designed to capture one's assets accumulation behavior well while lessening computational burden. The savings variable is continuous, and it is discretized. The finer it is discretized, the more accurately the assets accumulation behavior can be captured yet the heavier is the computational burden of solving the model. If the difference measure is used, then the range of the difference is very large and thus should be discretized into many points, increasing computational burden. Therefore, a rate measure is used if the current assets is not zero. However, the traditional savings measure of $\frac{W_{a+1}-W_a}{W_a}$ can be very large if the current assets level is very low or if the next period's level of assets is very high compared to the current assets level. To solve this problem, I transform the savings rate as defined above and use the transformed savings measure so that the lower limit of the measure is -1 and its upper limit is 1. The rate measure cannot be used if one's current assets is zero. However, it is reasonable to assume that the next period's assets that an individual with zero current assets can accumulate will be limited. Thus, I use the difference measure if one's current assets is reported to be zero. The savings thus defined is discretized into 9 points. The rate measure is discretized into one of the points in $\{-1.0, -0.7, -0.4, -0.2, 0.0, 0.2, 0.4, 0.7, 0.95\}$ and the difference measure in $\{\$0, \$200, \$600, \$1000, \$3000, \$5000, \$7000, \$10000, \$20000\}$.

status, I use the variable of whether one is alive or not from the tracker file used to merge waves of the HRS. Using the number of ADL deficiencies and the vital status, the health measure, H_a , is constructed: whether good, poor, or dead.

The assets, W_a , in this paper refer to non-housing assets, in consideration of Medicaid countable assets. For the assets variable, I use the imputed version of the assets from the HRS. Since the variable of assets is continuous, I discretize it.³⁴

I use the age variable, a , from the tracker file. One period of the model consists of two years. Ages 71 and 72 are grouped together, treated as the same age, and ages 73-74 together, and so on. Therefore, there are 15 grouped ages in total. As for the income variable, I_a , I use the imputed income of the HRS. I construct the level of education, e , using the variable of schooling years in the tracker file. There are four categories in the level of education. If one has schooling up to 6 years, then $e = 1$, meaning that she has educational attainment of elementary school or less. If one has schooling years from 7 to 11 years, then $e = 2$, meaning that she is classified as having dropped out of high school or having less education attainment than that. If one has 12 years of schooling, then $e = 3$, which means that she is an high school graduate. If one has more than 12 schooling years, then $e = 4$, which means that she has at least some college education. As for out-of-pocket costs for medical services other than nursing home, I use the variables for out-of-pocket payments for hospital stays, doctor and clinic visits, outpatient surgery, dental visits, prescriptions, and in-home-medical care.³⁵

If a person reports to have owned a LTCI policy, the HRS asks how long she has owned it. I use the duration of LTCI ownership data reported in the HRS to calculate the age of initial purchase of LTCI. The LTCI premium offer function presented in the previous section is for a given typical policy. The premium of LTCI also depends on daily benefits

³⁴I discretize the assets into 115 points: {0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 6000, 7000, 8000, 9000, 10000, 11000, 12000, 13000, 14000, 15000, 16000, 17000, 18000, 19000, 20000, 22000, 24000, 26000, 28000, 30000, 32000, 34000, 36000, 38000, 40000, 42000, 44000, 46000, 48000, 50000, 55000, 60000, 65000, 70000, 75000, 80000, 85000, 90000, 95000, 100000, 105000, 110000, 115000, 120000, 125000, 130000, 135000, 140000, 145000, 150000, 160000, 170000, 180000, 190000, 200000, 210000, 220000, 230000, 240000, 250000, 260000, 270000, 280000, 290000, 300000, 310000, 320000, 330000, 340000, 350000, 360000, 370000, 380000, 390000, 400000, 410000, 420000, 430000, 440000, 450000, 460000, 470000, 480000, 490000, 500000, 520000, 540000, 560000, 580000, 600000, 620000, 640000, 660000, 680000, 700000}.

³⁵The HRS asks the out-of-pocket payments for hospital stays and nursing home stays as one question. In order to isolate the out-of-pocket payments for hospital stays, therefore, I subtracted the approximate nursing home cost, considering her health insurance choice and health status, from the combined payments.

that the insurance policy provides as well as on issuance age. The HRS data, however, provide only limited information on policy benefits associated with LTCI holding. They provide information on whether or not a respondent's policy has an inflation protection feature and whether it covers nursing home, home care, or both. Yet, the data do not have information on the amount of daily benefits the policy provides. Thus, the premium data reported in the HRS reflect combined effects of issuance age and of daily benefits of the policy. I use premium data from a source other than the HRS in estimating the premium offer function given benefits of a typical LTCI policy, in order to isolate the effect of issuance age on the LTCI premium. I use average annual premiums in the individual long-term care insurance market by state and selected issue age from Johnson, Schaner, Toohey, and Uccello (2007), which summarizes Weiss Ratings, Inc. premium data from 2002.³⁶

7. Estimation

In this section, I explain the estimation methodology, the parameter estimates, and the model fits. I estimate the parameters of the model by the method of simulated maximum likelihood. I discuss how to construct the likelihood function, first. Then, I show the parameters estimated and present evidence on the within-sample fit of the model along various dimensions of the data.

7.1. Likelihood Function

I use the solution of the model as an input for the likelihood function. The numerical solution method described in Section 5 provides the Emax function. The Emax function is used to calculate the alternative-specific value functions, $V_a^j(\Omega_a)$ for $j = 1, \dots, J$.³⁷ Thus, the alternative-specific value functions are known up to random components of state space at age a . Conditional on the deterministic part of the state space, the probability that an individual is observed to choose alternative j corresponds to the integral over the region of a subset of the random shocks such that j is the preferred option.

³⁶The annual growth rate of premiums is assumed to be 3%.

³⁷ $J = 54$. The saving rates are discretized into nine points. Thus, the maximum number of alternatives is 54, since there are two nursing home use choices and three health insurance choices.

The likelihood function specifies the joint probability of observing a sequence of choices and outcomes in the data. The observed choices of an individual are her nursing home use, Medicaid enrollment, long-term care insurance ownership, and savings. The observed outcomes are her income, health status, and out-of-pocket costs for services other than nursing home. At any age a , I denote the vector of outcomes by $O_a = \{nh_a, hi_a, sr_a, I_a, H_a, mc_a^{om}\}$. Suppose we observe these outcomes for a sample of N households beginning at age a_{n0} and ending at age a_{nA} . Then, the likelihood for this sample is

$$L(\Theta) = \prod_{n=1}^N Pr(O_{(a_{n0},n)}, \dots, O_{(a_{nA},n)} | \bar{\Omega}_{(a_{n0},n)}, k),$$

where $\bar{\Omega}_{(a_{n0},n)}$ is the observable component of the initial state space at the first wave in the sample, that is, the state space net of the individual's type, k , and stochastic shocks at $a = a_{n0}$. The observable part of the state space at the first wave consists of state of residence, age, wealth, health, duration of LTCI holding, and education of the individual. Because type is unobserved, it must be integrated out. Thus, the sample likelihood is:

$$L(\Theta) = \prod_{n=1}^N \sum_{k=1}^K Pr(O_{(a_{n0},n)}, \dots, O_{(a_{nA},n)} | \bar{\Omega}_{(a_{n0},n)}, k) Pr(k | \bar{\Omega}_{(a_{n0},n)}).$$

Given the assumption of joint serial independence of the vector of shocks (conditional on type), the sample likelihood can be written as the product of within-period outcome probabilities conditional on the corresponding state space and type. The initial conditions are assumed to be exogenous conditional on type.

The outcome probability at a point in time can be calculated from the choice probability conditional on the state space and the probability of observing income, health and out-of-pocket costs for services other than nursing home. I compute the conditional choice probability using a kernel smoothed frequency simulator (McFadden (1989) and Eckstein and Wolpin (1999)). For each observed individual n , I draw error vectors to replicate Q hypothetical individuals with the same state points as the individual n . For each simulated person, I compute the alternative(j)-specific value functions in each period, $V(d_a^j(\Omega_a))$, using the solution of the model, the emax function, for all possible alternatives $j \in J$. Then,

the kernel of the integral for each of the draws is:

$$\frac{\exp \left[\frac{V(d_a^j(\Omega_a)) - \max_{d_a \in D_a} V(d_a(\Omega_a))}{\tau} \right]}{\sum_{j=1}^J \exp \left[\frac{V(d_a^j(\Omega_a)) - \max_{d_a \in D_a} V(d_a(\Omega_a))}{\tau} \right]}.$$

The conditional choice probability at the given period is obtained by the integration of the kernel. The expectation is obtained by Monte Carlo Integration (by averaging the above object over the draws).³⁸

If state variables are observed at all interview waves and respondents, the above likelihood can be obtained using the kernel smoothed frequency estimator and laws of motion. However, the state variables, such as the health measure, H_a , are not observed for all individuals at all points in time. If some state variables are unobserved, then one must integrate over the distribution of the unobserved elements to construct the outcome probabilities. For an observation that has any missing value in the initial condition, all possible values for that missing value are generated for that observation to be used for integration. If there is a missing value in choice variables or outcome variables, then I consider all paths of possible realization of choices and outcomes for that missing value given the initial condition (if observed) or the generated initial condition (if the initial condition is not observed). Then I construct the outcome probabilities for each possible path and integrate them over the distribution of the unobservable parts of the observation to obtain the individual's contribution to the likelihood function. Since the type probability also depends on health, which is sometimes missing, the type probability is also integrated together with the type-specific individual likelihood function.

The entire set of model parameters enters the likelihood through the choice probabilities that are computed from the solution of the dynamic programming problem. Subsets of parameters enter through other structural relationships as well, such as health transition functions and income process. The estimation procedure, i.e., the maximization of the likelihood function, iterates between the solution of the dynamic program and the calculation of the likelihood. As the optimization routine, I use the Lee and Wiswall (2007) simplex

³⁸The smoothing parameter, τ , was set equal to 0.1, which provided sufficient smoothing given the magnitudes of the value functions, and $Q = 300$.

method.³⁹

7.2. Parameter Estimates

The precise functional forms of the model's structure are provided in the Appendix. Tables 5 to 8 provides parameter estimates and associated standard errors. The parameters provide some evidence about the credibility of the model. The coefficient of relative risk aversion (CRRA, β_1) is estimated to be 1.115. This is close to CRRA estimates from the empirical literature (Van der Klaauw and Wolpin (2005), and Rust and Phelan (1997)).

The model was fit with two individual types. Types differ with respect to their underlying preferences (for LTCI holding, Medicaid enrollment, and nursing home use), out-of-pocket costs for services other than nursing home, and survival probability. Type 1 (Type 2) individuals comprise 17.5% (82.5%) of the sample. Type 2 individuals value holding LTCI more than type 1s ($\beta_2 < \beta_3$). Transitioning from no LTCI holding to LTCI holding is costly ($\beta_4 < 0$). Type 1 individuals value Medicaid enrollment more than type 2s ($\beta_5 > \beta_6$). Type 2 individuals draw negative utility from being on Medicaid ($\beta_6 < 0$), while type 1s' utility increases with Medicaid enrollment ($\beta_5 > 0$). Being in poor health increases preference for being on Medicaid ($\beta_7 > 0$). However, type 2 individuals' disutility from being on Medicaid is not offset by the increase in utility from being on Medicaid in poor health ($|\beta_6| > |\beta_7|$). Their aversion towards Medicaid exceeds the benefits of using health services that Medicaid provides for those in poor health. This result might be attributed to a stigma attached to the public welfare program, administration costs, and the psychic costs of going through health tests to meet the Medicaid level of care requirements. Transitioning from no nursing home use to nursing home use is estimated to be costly ($\beta_{10} < 0$). Being in poor health lessens resistance to entering a nursing home ($\beta_{11} > 0$). People tend to have less resistance to nursing home use as they age ($\beta_{12} > 0$).

7.3. Within-Sample Fit

I present evidence on the within-sample fit of the model along various dimensions of the data. Tables 9 to 17 provide evidence on the within-sample fit of the model. Table 9 provides model fits of health status. The model-predicted health status closely matches that from the actual data in that most of the elderly in their 70s are healthy and the percentage

³⁹Lee and Wiswall simplex method is a generalization of the Nelder-Mead (1967) simplex algorithm.

of people in good health decreases with age. The transition from the current health status to the next period's health status is presented in Table 10. The model is able to capture the actual health transition reasonably well. The probability of death in the next period, conditional on each health status, is close to the corresponding probability from the actual data. The persistence of good health is closely captured, while the persistence of poor health is not as well predicted. The small sample size of those in poor health may explain the worsened goodness of fit in the poor health persistence.

Table 11 provides the model fit of nursing home use by age. The model well captures the pattern observed in the data that nursing home use rises with age. The transition from no nursing home use is well predicted by the model, as shown in Table 12, while the transition from nursing home use is not as well predicted. Table 13 compares the model's prediction of the distribution of health insurance choices by age to the actual distribution. The model captures the pattern in the data that the percentage of LTCI holding decreases with age. The transition across health insurance choices is shown in Table 14. The overall magnitudes of persistence of and transition from the no health insurance choice, i.e. neither LTCI nor Medicaid, relatively well match those of the actual data. However, due to the parsimony of the model, the model underpredicts lapse rates of LTCI and the persistence of Medicaid enrollment.

Figures 2 and 3 present the actual and predicted distributions of assets by age. The model captures the decreasing pattern of the mean assets with age.

The model fits are also provided in a different dimension of the data. Table 15 provides the model fit of health status by waves. It compares the actual number of people alive in each wave with the predicted number of people alive in the corresponding wave. Conditional on being alive, the percentage of people in good (poor) health from the actual data is compared with that from the simulated data from the model in each wave. Each health status is well predicted. The χ^2 values on the last column are for the model fits of health status conditional on being alive in each wave. According to the χ^2 s, the model fit is found to be good. Tables 16 and 17 present the model fits of nursing home use and health insurance choices by wave. The model fits are good, according to the χ^2 test.

8. Policy Experiments

Using the estimated parameters, I conduct three counterfactual policy experiments to estimate the Medicaid crowd-out effects and the impact of tax subsidies on LTCI demand. First, I simulate the effect of eliminating the Medicaid program to examine the Medicaid crowd-out effects on LTCI demand and savings. Second, I simulate the effect of various degrees of Medicaid aversion on the demand for LTCI and Medicaid enrollment rates to investigate how assumptions on Medicaid take-ups affect the estimated Medicaid crowd-out effects. Third, I simulate the effect of premium reduction on LTCI demand to estimate the price elasticity of LTCI demand.

8.1. Medicaid Removal

I eliminate the Medicaid program to investigate the extent to which the public program crowds out private long-term care insurance and savings. By completely removing Medicaid, I eliminate any implicit tax that Medicaid imposes on LTCI.⁴⁰ Brown, Coe, and Finkelstein (2006) quantify the Medicaid crowd-out effect using variations in Medicaid asset eligibility limits by state of residence and find small effects of stringency in Medicaid asset limits on LTCI demand. To explain the small effects, they argue that the stringency in Medicaid asset limits may not significantly affect the Medicaid implicit tax since the tax stems from the design of Medicaid itself.⁴¹ In my paper, I *empirically* estimate the importance of the Medicaid implicit tax in explaining the limited demand for LTCI by simulating the effect of the *complete removal of Medicaid and thus its implicit tax* on LTCI demand.

The removal of Medicaid affects the behavior of individuals regarding not only their LTCI holding but also their savings and nursing home use. In the absence of Medicaid, 10.0% of the elderly individuals aged 71 to 90 have LTCI, while 9.5% do in its presence. Thus, the existence of Medicaid crowds out LTCI demand by 5.3%. However, the crowd-out effect on savings is greater, increasing median assets by 15.3%. In summary, the

⁴⁰As explained in the introduction, the Medicaid implicit tax refers to the redundant long-term care benefits provided by private insurance that Medicaid would have provided had the individual not purchased private insurance.

⁴¹Brown and Finkelstein (2008) explain that the Medicaid implicit tax stems from two features of Medicaid's design. First, holding LTCI reduces the probability that the policy holder will meet the Medicaid asset-eligibility requirement. Second, Medicaid is a secondary payer when the individual has private insurance.

Medicaid crowd-out effect on LTCI demand is small. Therefore, Medicaid reform might not influence LTCI demand significantly.

Rather than changing their LTCI purchasing behavior, people tend to respond to the elimination of Medicaid more by changing their nursing home use behavior. Fewer people use a nursing home, and thus potentially more people use informal care, in the absence of Medicaid. 5.9% of those aged 71 to 90 would use a nursing home without Medicaid, whereas 7.8% use it in the presence of Medicaid (Table 18).

8.2. Various Degrees of Medicaid Aversion

Individuals with Medicaid aversion or high costs of enrolling in Medicaid may prefer long-term care benefits from private coverage than those from Medicaid. For such individuals, Medicaid would not be an important substitute for LTCI, and thus the Medicaid crowd-out effect on LTCI demand for those people would be smaller than that for those with positive preference on Medicaid who would enroll in Medicaid upon meeting eligibility criteria. The Medicaid crowd-out effect on LTCI demand would be overestimated if the former individuals were treated in the same way as the latter. By counterfactual experiments, I examine how the degrees of Medicaid aversion affect the estimated Medicaid crowd-out of LTCI demand.

I vary the coefficients of the preference on Medicaid to examine how the demand for LTCI and Medicaid enrollment rates would change under the different degrees of preference on Medicaid. As explained in Section 7, type 1 individuals have positive preference towards being on Medicaid, while type 2s do not. I perform hypothetical experiments in which preferences on Medicaid of each type vary. Figures 4 and 5 present the percentage of people holding LTCI and the Medicaid enrollment rates before and after the changes in Medicaid preferences. In the first experiment, type 2 individuals have the same preference on Medicaid as type 1s. That is, type 2 individuals have positive preference on being on Medicaid. In this hypothetical situation, the percentage of those holding LTCI declines and Medicaid enrollment rates rise. For example, the percentage of individuals holding LTCI among those aged 71 to 80 drops by 27.1% (from 11.8% to 8.6%). Since type 2 individuals no longer have Medicaid aversion, more of them enroll in Medicaid and fewer hold LTCI. Therefore, with positive Medicaid preference, the degree to which Medicaid crowds out LTCI demand is estimated to be higher.

In the second experiment, type 1 individuals have the same preference to Medicaid

as type 2s. That is, type 1 individuals have negative preference towards being on Medicaid. Medicaid enrollment rates drop and the percentage of holding LTCI increases, though only slightly.⁴² Hence, if the entire elderly population has negative preference on Medicaid enrollment, the estimated Medicaid crowd-out effect on LTCI demand is smaller than if only a fraction of the population does.

Type 2 individuals, comprising the majority of the sample (82.5%), are estimated to have negative preference towards being on Medicaid. They tend not to enroll in Medicaid, though eligible. Considering the large size of people with Medicaid aversion in the sample, it is important to make the Medicaid enrollment decision endogenous in order to accurately estimate the Medicaid crowd-out effects.

8.3. Price Elasticities of LTCI Demand

Tax subsidies reduce the LTCI premium that potential policy purchasers face. The reduced premium might enable individuals who could not afford to buy LTCI without subsidies to afford it. The magnitude of changes in their LTCI purchase behaviors depends on price elasticities of LTCI demand. Thus, I simulate the effect of premium reduction on LTCI demand. I suppose individuals face half the premiums that were offered before subsidy. The percentage holding LTCI among those aged 71 to 80 increases by only 4.2% (from 11.8% to 12.3%) after subsidy. Thus, the estimated price elasticity of LTCI demand for the group is -0.08. This result indicates that price does not play an important role in the LTCI purchase decision and that a policy aiming to reduce LTCI premiums would have only a small effect on the uninsured. The estimated price elasticity is smaller in magnitude than that found in the previous literature, which does not take into account the dynamic aspect of LTCI decisions.⁴³ This relatively smaller estimated price elasticity in part comes from the dynamic feature of my model. Due to the unique structure of LTCI pricing, the current premiums that individuals are offered depend on their previous LTCI holding decisions. Thus, their behavioral changes regarding LTCI purchases after subsidy reflects both the exogenous premium changes induced by tax subsidies and their optimization based on the LTCI premium structure. The small estimated price elasticity of LTCI demand suggests that

⁴²The small magnitude of the estimated LTCI holding percentage increase is expected since only a small number of type 1 individuals had LTCI before the experiment.

⁴³The estimated price elasticity ranges from -0.75 to -3.9 (Johnson, Schaner, Toohey, and Uccello (2007), Goda (2009), and Courtemanche and He (2009)).

tax subsidies are unlikely to have a significant effect on reducing the number of uninsured.

9. Conclusions

Only a small fraction (approximately 10%) of the elderly has private long-term care insurance. A large percentage of long-term care expenditures are paid by Medicaid. The high cost to the government of financing long-term care has prompted proposals to make private long-term care insurance (LTCI) more affordable through tax incentives. The effectiveness of tax incentives for stimulating LTCI demand depends in part on the availability of Medicaid, which may be considered a crucial substitute for LTCI. Government financing of long-term care via Medicaid can *crowd out* the market for LTCI (Pauly (1989) and Brown and Finkelstein (2008)). Therefore, an assessment of policies for stimulating the LTCI market depends on the magnitude of the Medicaid crowd-out effect.

In this paper, I examine the impact of tax subsidies and Medicaid financing on the demand for LTCI by developing and estimating a stochastic dynamic model of the decision to purchase private long-term care insurance. The model also incorporates decisions on Medicaid enrollment, nursing home use, and asset holdings. Endogeneity of the Medicaid enrollment decision, as opposed to assuming automatic enrollment in Medicaid upon meeting Medicaid eligibility criteria, is an important feature and key contribution in my model that has not been taken into account in earlier work. Individuals with Medicaid aversion or high costs of enrolling in Medicaid may not regard Medicaid as a significant substitute for LTCI. The Medicaid crowd-out effect on LTCI demand would be lower in the presence of such individuals than in their absence. In addition, I take state-specific Medicaid eligibility criteria into account in modeling the Medicaid enrollment decision.

I solve the dynamic programming decision model and estimate the structural parameters of the model by simulated maximum likelihood, using the model solution as an input for the likelihood function. I use data from the Health and Retirement Study (HRS) for the years 1998 to 2002. The state-of-residence variable from the HRS data is particularly important because Medicaid eligibility rules differ by state of residence. The state-specific Medicaid eligibility criteria serve as an important source of exogenous variation when estimating the model.

In the model, elderly individuals make dynamic decisions in the face of uncertainties. In each period, they receive shocks to their income, health, preferences, and out-of-pocket

costs for services other than nursing home care. The individuals maximize their expected life-time utility subject to budget constraints, Medicaid eligibility rules, health transition functions, and other laws of motion. Nursing home use affects the probability of surviving to the next period and the quality of life, depending on their health status. Buying private long-term care insurance in the current period enables nursing home use at low cost some-time in the future. The current choice of LTCI affects the next period's LTCI premium offer because the LTCI premium schedule depends on the issuance age. Current asset levels, as determined by previous savings decisions, affect individuals' eligibility for Medicaid.

Using the estimated parameters, I perform three counterfactual policy experiments to estimate the impact of tax policy and Medicaid financing on LTCI demand. First, I simulate the effect of removing Medicaid for the elderly. Second, I simulate the effect of changing the degrees of Medicaid preferences on LTCI demand. Third, I simulate how many more people buy LTCI in response to a reduction in premiums. The main finding is that both the price elasticity of and the Medicaid crowd-out effect on LTCI demand are small. The estimated price elasticity of the LTCI demand is -0.08 , implying that tax subsidies are expected to have only a limited effect in reducing the number of uninsured. However, the policy's low impact on LTCI demand does not seem to be due to the Medicaid crowd-out effect. Eliminating the Medicaid program increases LTCI holding by only 5.3% (from 9.5% to 10.0%). Hence, even without Medicaid — and thus its implicit tax on the benefits from LTCI policies — the demand for LTCI would remain small. On the other hand, individuals reduce nursing home use, potentially increasing informal care use, and/or save more in response to the removal of Medicaid. Thus, they tend to react more by changing the mode of long-term care services or by increasing savings than by increasing LTCI holding.

Other counterfactual policy experiments support the importance of making Medicaid enrollment decisions endogenous. A large fraction of the sample (82.5%) is estimated to have an aversion to Medicaid. In the presence of such individuals, the estimated Medicaid crowd-out effect on LTCI demand is lower than in their absence, because they would rather save more or purchase LTCI than plan on using Medicaid in preparation for future nursing home risks. The policy experiments show that the Medicaid crowd-out effect on LTCI demand is overestimated if they are treated the same way as those with positive preference towards Medicaid. The latter group would enroll in Medicaid upon meeting eligibility criteria. Therefore, making the Medicaid enrollment decision endogenous is crucial in accurately estimating Medicaid crowd-out effects when Medicaid aversion is present.

Considering the small Medicaid crowd-out effect on LTCI demand, Medicaid reform

might not have a significant impact on LTCI demand. This result is in contrast to the previous literature which suggests that Medicaid reform is necessary for the LTCI market to expand considerably. Policies to boost the LTCI market may need to focus on the product characteristics of LTCI. Recently, private insurance firms have started offering coverage for informal care. The model presented in this paper can be extended to explore the effects of this new feature of LTCI, by distinguishing informal care from the no nursing home use decision.⁴⁴ The current model can also be extended to analyze spousal decisions on LTCI holding, Medicaid enrollment, and nursing home use, which will help policy makers design alternative policies on the purchase of LTCI by not only elderly single women but also the broader population.

⁴⁴The decision to use informal care is embedded in the no nursing home use decision in the current paper, following Brown and Finkelstein (2008). They show that, even without informal care, the Medicaid crowd-out effect is considerable.

Appendix I. Functional Forms

A.1. Utility function

$$\begin{aligned}
 u_a = & \frac{C_a^{1-\beta_1} - 1}{1 - \beta_1} \exp(\epsilon_a^c) \\
 & + I(hi_a = 1) \{ \beta_2 I(k = 1) + \beta_3 I(k = 2) + \beta_4 I(hi_{a-1} \neq 1) + \epsilon_a^l \} \\
 & + I(hi_a = 2) \{ \beta_5 I(k = 1) + \beta_6 I(k = 2) + \beta_7 I(H_a = 2) + \epsilon_a^m \} \\
 & + I(nh_a = 1) \{ \beta_8 I(k = 1) + \beta_9 I(k = 2) + \beta_{10} I(nh_{a-1} \neq 1) + \\
 & \quad + \beta_{11} I(H_a = 2) + \beta_{12} a + \beta_{13} a I(nh_a = 1) + \epsilon_a^n \}
 \end{aligned} \tag{1}$$

A.2. Survival Probability: $\pi_a^s = P(H_{a+1} \neq 0 | H_a = h)$

$$\pi_a^s = \frac{\exp[\phi_0^{h,0} + \phi_1^{h,0} a + \phi_2^{h,0} I(nh_a = 1) + \phi_3^{h,0} a I(nh_a = 1) + \phi_4^{h,0} I(k = 1)]}{1 + \exp[\phi_0^{h,0} + \phi_1^{h,0} a + \phi_2^{h,0} I(nh_a = 1) + \phi_3^{h,0} a I(nh_a = 1) + \phi_4^{h,0} I(k = 1)]} \tag{2}$$

A.3. Health Transition Function: $\pi_a^{h,h'} = P(H_{a+1} = h' | H_a = h)$

$$\pi_a^{h,h'} = \frac{\exp[\phi_0^{h,h'} + \phi_1^{h,h'} a]}{\sum_{h'=1} \exp[\phi_0^{h,h'} + \phi_1^{h,h'} a]} \tag{3}$$

A.4. Income Process

$$\ln I_a = \theta_0 + \theta_1 e + \theta_2 a + \epsilon_a^i$$

A.5. Medical cost for services other than nursing home

$$mc_a^{om} = \begin{cases} mc_a^{om*} & \text{if } mc_a^{om*} > 0 \\ 0 & \text{if } mc_a^{om*} \leq 0 \end{cases} \tag{4}$$

$$mc_a^{om*} = \psi_0 + \psi_1 a + \psi_2 I_a + \psi_3 I(k = 1) + \epsilon_a^{om}$$

A.6. Type Probability Function

$$P(k = 1) = \frac{\exp[\eta_0 + \eta_1 a_0 + \eta_2 e + \eta_3 W_{a_0} + \eta_4 I\{H_{a_0} = 2\}]}{1 + \exp[\eta_0 + \eta_1 a_0 + \eta_2 e + \eta_3 W_{a_0} + \eta_4 I\{H_{a_0} = 2\}]} \quad (5)$$

Appendix II. Tables and Figures

Table 1: Summary Statistics

		Average (S.D.)*	Median	Min	Max
Age	[yrs]	81.5 (6.5)	81	71	99
Schooling	[yrs]	10.7 (3.9)	12	0	17
Assets	[\$]	67,749.3 (123,309.1)	11,000	0	681,500
Income	[\$]	16,435.1 (17,952.4)	11,304	0	237,000
ADL \geq 3	[%]	19.6			
LTCI	[%]	9.0			
Medicaid	[%]	21.1			
Nursing Home	[%]	8.2			

* Standard Deviations

Table 2: Characteristics of LTCI Holders and Medicaid Enrollees

		LTCI Holders	Neither	Medicaid Enrollees
		Mean (S.D)*	Mean (S.D)	Mean (S.D)
Age	[yrs.]	80.0 (6.4)	81.4 (6.4)	82.9 (7.2)
ADL	[#]	0.8 (1.5)	1.0 (1.7)	2.0 (2.3)
Assets	[\$1000]	218.2 (283.9)	98.3 (193.4)	3.0 (19.8)
Schooling	[yrs.]	12.7 (2.1)	11.5 (3.2)	6.9 (4.2)

*Standard Deviations

Table 3: Distribution of Choice Variables by Age

Age	(# obs.)	LTCI(%)	Medicaid(%)	Nursing Home(%)
73-74	(88)	15.9	18.2	1.1
75-76	(127)	15.7	18.1	1.6
77-78	(158)	12.0	17.7	2.5
79-80	(173)	11.6	17.3	4.0
81-82	(174)	7.5	15.5	4.6
83-84	(155)	6.5	15.5	7.1
85-86	(139)	9.4	23.0	10.8
87-88	(124)	6.5	27.4	12.1

- (1) Percentage choosing each choice variable
(2) The age group 71-72 has fewer than 50 observations.

Table 4: Distribution of State Variables by Age

Age	(# obs.)	Health	Assets
		ADL>2 (%)*	Mean (\$)
73-74	(88)	15.9	90,291
75-76	(127)	15.7	90,824
77-78	(158)	12.0	78,527
79-80	(173)	11.6	75,065
81-82	(174)	7.5	70,120
83-84	(155)	6.5	68,930
85-86	(139)	9.4	57,298
87-88	(124)	6.5	65,953

(1) *Percentage of people with more than two problems with ADL

(2) The age group 71-72 has fewer than 50 observations.

Table 5: Parameter Estimates

Parameter		Estimates
Utility Function		
β_1	CRRA	1.115 (0.024)
β_2	LTCI (Type 1)	-0.196 (0.878)
β_3	LTCI (Type 2)	0.259 (0.060)
β_4	LTCI (Lag)	-3.856 (0.467)
β_5	Medicaid (Type 1)	0.473 (0.072)
β_6	Medicaid (Type 2)	-0.286 (0.062)
β_7	Medicaid (Poor Health)	0.188 (0.088)
β_8	Nursing Home (Type 1)	0.548 (1.216)
β_9	Nursing Home (Type 2)	0.972 (1.111)
β_{10}	Nursing Home (Lag)	-5.431 (2.177)
β_{11}	Nursing Home (Poor Health)	1.672 (3.154)
β_{12}	Nursing Home (Age)	0.033 (0.060)
β_{13}	Nursing Home (Health & Age)	0.035 (0.238)

Standard errors are in parenthesis.

Table 6: Parameter Estimates (cont.)

Parameter		Estimates
Health Transition		
$\phi_0^{h=1,h'=0}$	Constant: Good to Survival	2.162 (0.183)
$\phi_0^{h=2,h'=0}$	Constant: Poor to Survival	2.102 (0.421)
$\phi_1^{h=1,h'=0}$	Age: Good to Survival	-0.033 (0.024)
$\phi_1^{h=2,h'=0}$	Age: Poor to Survival	-0.127 (0.044)
$\phi_2^{h=1,h'=0}$	NH: Good to Survival	-0.583 (0.266)
$\phi_2^{h=2,h'=0}$	NH: Poor to Survival	-0.271 (0.605)
$\phi_3^{h=1,h'=0}$	Age & NH: Good to Survival	0.003 (0.027)
$\phi_3^{h=2,h'=0}$	Age & NH: Poor to Survival	0.005 (0.047)
$\phi_4^{h=1,h'=0}$	Type 1: Good to Survival	-0.302 (0.125)
$\phi_4^{h=2,h'=0}$	Type 1: Poor to Survival	-0.493 (0.379)
$\phi_0^{h=1,h'=1}$	Constant: Good to Good	2.635 (0.273)
$\phi_0^{h=2,h'=1}$	Constant: Poor to Good	2.049 (0.378)
$\phi_1^{h=1,h'=1}$	Age: Good to Good	-0.179 (0.032)
$\phi_1^{h=2,h'=1}$	Age: Poor to Good	-0.255 (0.054)

Standard errors are in parenthesis.

Table 7: Parameter Estimates (cont.)

Parameter		Estimates
Type Probability		
η_1	Constant	2.026 (0.666)
η_2	Initial Age	-0.072 (0.059)
η_3	Education	-0.596 (0.187)
η_4	Initial Wealth	-0.189 (0.038)
η_5	Initial Poor Health	-0.084 (0.575)
Out-of-pocket Payments for Services Othr Than Nursing Home Care		
ψ_1	Const.	1378.503 (55.773)
ψ_2	Age	-43.856 (6.840)
ψ_3	Income	0.032 (0.015)
ψ_4	Type1	-1306.206 (78.249)

Standard errors are in parenthesis.

Table 8: Parameter Estimates (cont.)

Parameter		Estimates
<u>Income Process</u>		
θ_1	Constant	9.499 (0.018)
θ_2	Age	0.308 (0.002)
θ_3	Education	-0.029 (0.002)
<u>LTCI Premium</u>		
α_0	Constant	6.913 (0.022)
α_1	Issuance Age	0.152 (0.005)
<u>Variances</u>		
σ_c	S.D. of Consumption Shock	0.316 (0.178)
σ_l	S.D. of LTCI preference Shock	1.321 (0.132)
σ_m	S.D. of Medicaid preference Shock	0.219 (0.214)
σ_n	S.D. of NH preference Shock	2.619 (0.407)
σ_i	S.D. of Income Shock	0.625 (0.009)

Standard errors are in parenthesis.

Table 9: Model Fit: Health Status by Age

Age	(# obs.)	Poor Health (%)		Good Health (%)	
		Actual	Pred.	Actual	Pred.
73-74	(88)	6.8	5.8	93.2	94.2
75-76	(127)	7.1	5.4	92.9	94.6
77-78	(158)	10.8	12.6	89.2	87.4
79-80	(173)	8.7	11.2	91.3	88.8
81-82	(174)	14.9	16.7	85.1	83.3
83-84	(155)	19.4	19.9	80.6	80.1
85-86	(139)	16.5	19.5	83.5	80.5
87-88	(124)	21.0	24.5	79.0	75.5

- (1) Percentage in each health status
- (2) The age group 71-72 has fewer than 50 observations.
- (3) $\chi^2 = 3.51$, $\chi^2(.05, 1) = 3.84$

Table 10: Model Fit: Health Transitions

Health at age a		Health at age $a + 1$		
		0	1	2
1	Actual	11.2	79.0	9.9
	Predicted	12.7	71.7	15.5
2	Actual	35.3	21.2	43.6
	Predicted	30.4	35.3	34.3

The health statuses are: 0=dead, 1=good, 2=poor

Table 11: Model Fit: Nursing Home Choice by Age

Age	(# obs.)	NH use (%)		No NH use(%)	
		Actual	Pred.	Actual	Pred.
73-74	(88)	1.1	1.5	98.9	98.5
75-76	(127)	1.6	1.6	98.4	98.4
77-78	(158)	2.5	2.5	97.5	97.5
79-80	(173)	4.0	3.2	96.0	96.8
81-82	(174)	4.6	4.1	95.4	95.9
83-84	(155)	7.1	7.9	92.9	92.1
85-86	(139)	10.8	11.8	89.2	88.2
87-88	(124)	12.1	15.1	87.9	84.9

(2) The age group 71-72 has fewer than 50 observations.

(3) $\chi^2 = 1.17$, $\chi^2(.05, 1) = 3.84$

Table 12: Model Fit: Nursing Home (NH) Choice Transitions

NH at age a		NH at age $a + 1$	
		0	1
0	Actual	95.4	4.6
	Predicted	93.1	6.9
1	Actual	14.3	85.7
	Predicted	26.7	73.3

Nursing home choices: 0=no nursing home use, 1=nursing home use

Table 13: Model Fit: Health Insurance Choices by Age

Age	(# obs.)	LTCI (%)		Medicaid (%)		Neither (%)	
		Actual	Pred.	Actual	Pred.	Actual	Pred.
73-74	(88)	15.9	13.8	18.2	11.7	65.9	74.5
75-76	(127)	15.7	13.2	18.1	12.9	66.2	73.9
77-78	(158)	12.0	12.1	17.7	14.2	70.3	73.7
79-80	(173)	11.6	10.2	17.3	16.1	71.1	73.7
81-82	(174)	7.5	8.2	15.5	16.4	77.0	75.4
83-84	(155)	6.5	8.3	15.5	17.0	78.0	74.7
85-86	(139)	9.4	7.1	23.0	20.0	67.6	72.9
87-88	(124)	6.5	8.3	27.4	22.3	66.1	69.4

(1) Percentages holding LTCI, being on Medicaid, and having neither

(2) The age group 71-72 has fewer than 50 observations.

(3) $\chi^2 = 4.31$, $\chi^2(.05, 2) = 5.99$

Table 14: Model Fit: Health Insurance (HI) Choice Transitions

HI at age a		HI at age $a + 1$		
		0	1	2
0	Actual	90.7	2.4	6.9
	Predicted	87.7	2.1	10.2
1	Actual	25.3	72.4	2.3
	Predicted	13.0	85.7	1.3
2	Actual	12.1	0.0	87.9
	Predicted	22.8	0.2	77.0

The health insurance choices: 0=neither LTCI nor Medicaid, 1=LTCI, 2=Medicaid

Table 15: Model Fit: Health Status by Wave

Ages in 1998: 71-80

Year	# Alive		Good Health (%)		Poor Health (%)		χ^2
	Actual	Pred.	Actual	Pred.	Actual	Pred.	
1998	268	268.0	90.7	90.7	9.3	9.3	0.0
2000	237	236.4	89.5	88.4	10.5	11.6	0.28
2002	216	204.0	86.6	85.8	13.4	14.2	0.11

$\chi^2(.05, 1) = 3.84$

Ages in 1998: 81-90

Year	# Alive		Good Health (%)		Poor Health (%)		χ^2
	Actual	Pred.	Actual	Pred.	Actual	Pred.	
1998	242	242.0	81.8	81.8	18.2	18.2	0.0
2000	196	200.0	79.6	75.4	20.4	24.5	1.86
2002	149	162.8	74.5	69.9	25.5	29.9	1.50

Table 16: Model Fit: Nursing Home Choices by Wave

Ages in 1998: 71-80

Year	NH use (%)		No NH use (%)		χ^2
	Actual	Pred.	Actual	Pred.	
1998	0.0	1.9	100.0	98.1	5.19
2000	1.3	2.6	98.7	97.4	1.58
2002	4.6	3.8	95.4	96.2	0.38

$\chi^2(.05, 1) = 3.84$

Ages in 1998: 81-90

Year	NH use (%)		No NH use (%)		χ^2
	Actual	Pred.	Actual	Pred.	
1998	11.2	12.9	88.8	87.1	0.62
2000	11.7	16.0	88.3	84.0	2.70
2002	14.1	20.1	85.9	79.9	3.34

Table 17: Model Fit: Health Insurance Choices by Wave

Ages in 1998: 71-80

Year	LTCI (%)		Medicaid (%)		Neither (%)		χ^2
	Actual	Pred.	Actual	Pred.	Actual	Pred.	
1998	11.2	10.0	16.4	15.2	72.4	74.8	0.85
2000	11.8	10.9	19.4	14.9	68.8	74.2	4.33
2002	11.6	11.8	20.4	15.0	68.0	73.2	5.00

Ages in 1998: 81-90

Year	LTCI (%)		Medicaid (%)		Neither (%)		χ^2
	Actual	Pred.	Actual	Pred.	Actual	Pred.	
1998	7.4	6.3	19.4	23.5	73.2	73.6	0.34
2000	6.6	6.7	24.5	27.5	68.9	69.6	0.16
2002	5.4	6.9	30.2	31.4	64.4	66.3	1.52

$$\chi^2(.05, 2) = 5.99$$

Table 18: Effects of Medicaid Removal on LTCI and Nursing Home

	Medicaid	No-Medicaid
LTCI (%)	9.5	10.0
NH (%)	7.8	5.9

Table 19: Effects of Medicaid Removal on Assets

Assets(\$)	% of those in each assets group	
	Medicaid	No-Medicaid
[0,2000]	27.3	16.8
(2000,10000]	26.7	35.5
(10000,50000]	14.1	15.5
(50000,200000]	17.0	17.0
(200000,700000]	14.8	15.2

Table 20: Medicaid Rules by State of Residence

State	Program	\bar{W}_s (\$)	\bar{I}_s (month, \$)	pna_s (\$)
Texas	CN	\$2,000	\$1,482	\$45
California	MN	\$2,000	\$600	\$35
Michigan	MN	\$2,000	\$408	\$60
New York	MN	\$3,500	\$584	\$50
Florida	MN	\$5,000	\$180	\$35

(1) Sources: Medicaid Income and Asset Limits by Categorically and Medically Needy Status for Nursing Home Services, by state in 1998 are from Gardner and Gilleskie (2006). Personal Needs Allowances in 2000 are from Stone (2002).

(2) CN: Categorically Needy

(3) MN: Medically Needy

(4) pna_s : personal needs allowance

Figure 1: Health Insurance and Nursing Home(NH) Percentages by Age (HRS)

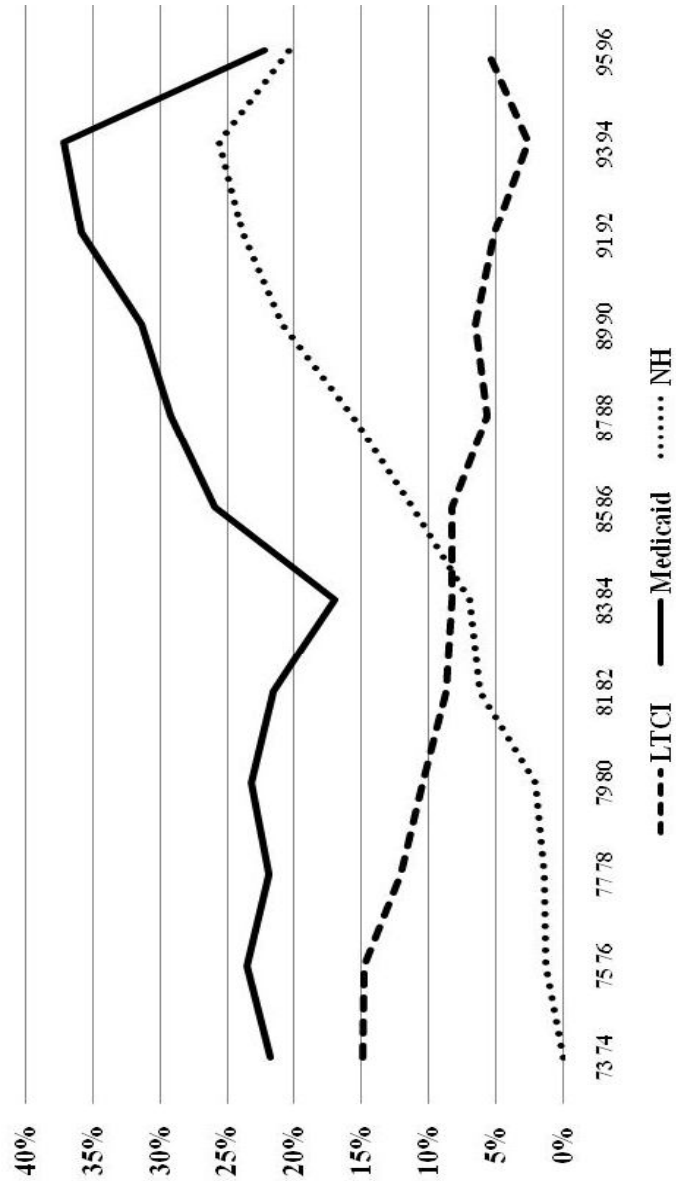
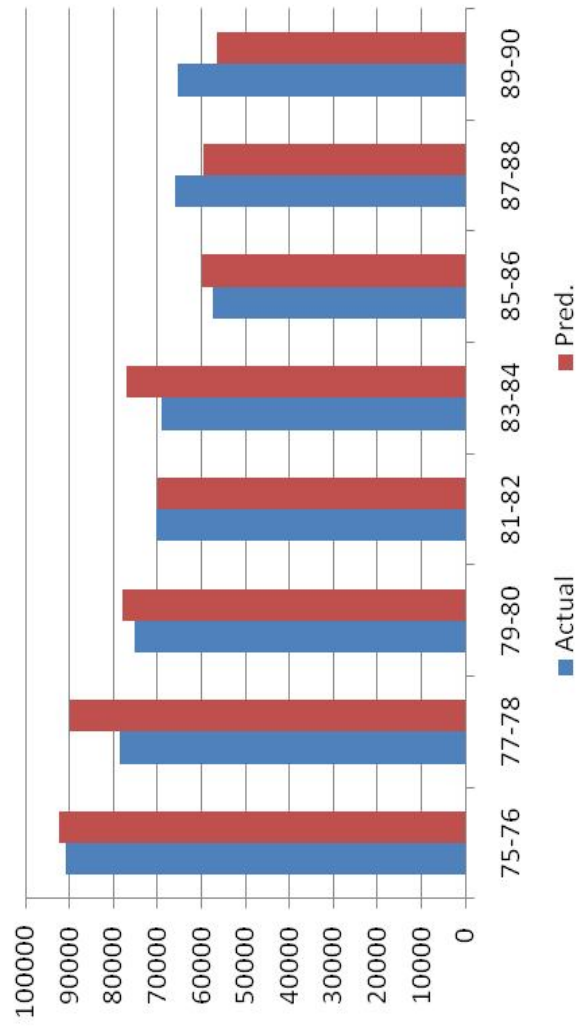


Figure 2: Mean Assets by Age (HRS)



Y axis: Assets in \$, X axis: Ages in years

Figure 3: Median Assets by Age (HRS)

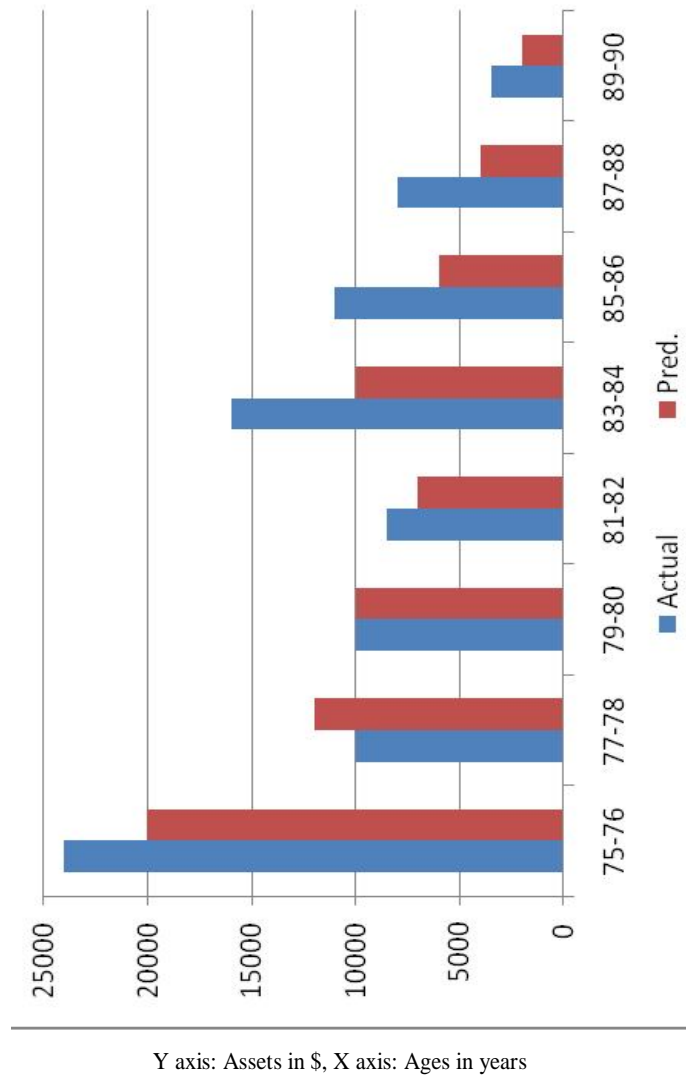


Figure 4: Various Degrees of Medicaid Preference and LTCI

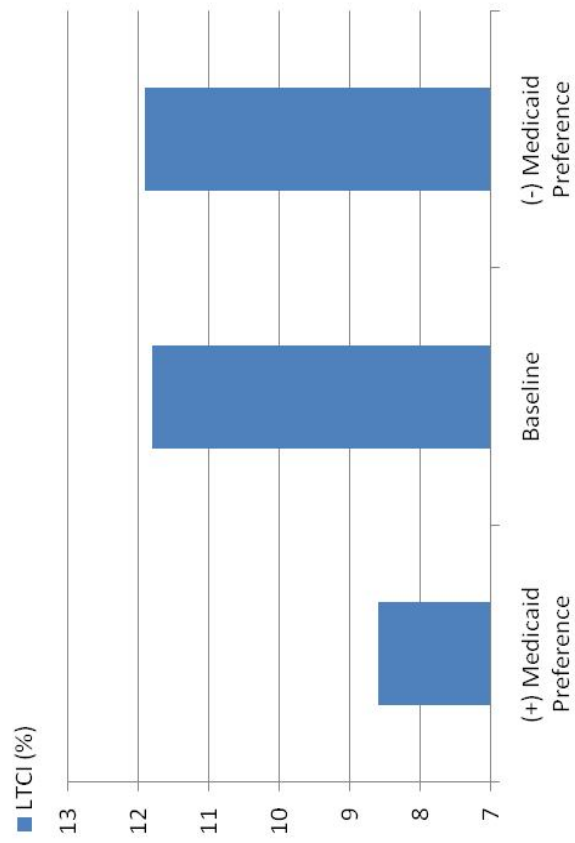
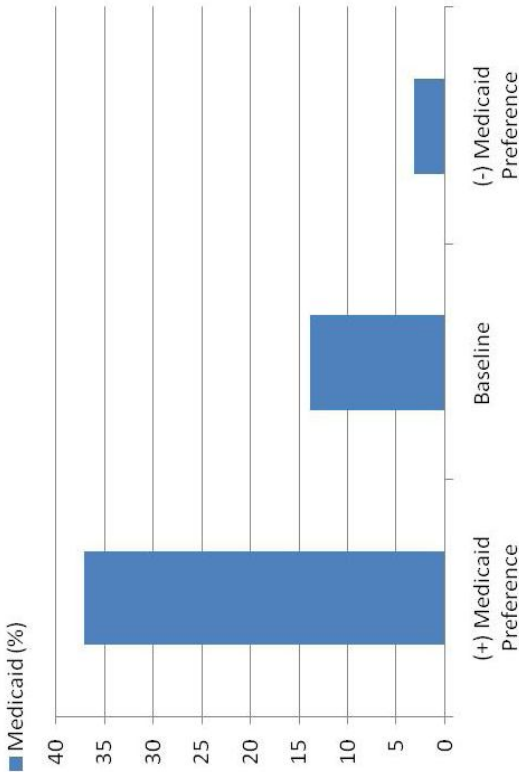


Figure 5: Various Degrees of Medicaid Preference and Medicaid



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