The Influence of Pre-Existing Conditions on the Risk of Using a Nursing Home

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Abstract

Preparing for the financial risk due to utilizing long-term services and supports (LTSS) has become an integral part of retirement planning. Long-term care insurance (LTCI) is an option to finance LTSS expenditures, and its role in retirement planning may grow as Americans are increasingly more responsible for their own retirement security. However, not all people are eligible to purchase LTCI coverage because to deter adverse selection, insurers deny coverage to individuals with pre-existing conditions. This paper estimates that 36% of individuals in their 50s have pre-existing conditions which may prevent them from obtaining LTCI coverage. The results show pre-existing conditions are associated with a 9-percentage-point increase in the lifetime likelihood of using a nursing home. This increase is a lasting effect. The findings can be applied to enhance consumers' knowledge about the possibility of LTCI coverage rejection, resulting in improved retirement planning.

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1. Introduction

Long-term services and supports (LTSS) refer to the types of assistance provided to functionally- and/or cognitively-impaired individuals who cannot independently perform routine daily activities. Demand for LTSS is expected to grow in the coming decades because of increasing life expectancy, and the likelihood of being functionally and/or cognitively impaired increases with age. Prices of LTSS have been rising over time. The growing demand for and the rising costs of LTSS make preparing for the financial risk due to utilizing LTSS an integral part of retirement planning. The options to finance LTSS expenditures include Medicare, Medicaid, long-term care insurance (LTCI), and self-insurance (i.e., paying out-of-pocket). In 2011, 36% of national LTSS expenditures were paid by Medicare, 31% by Medicaid, 20% out of pocket, and only 6% by LTCI (Congressional Budget Office 2013). This small percentage is consistent with the low LTCI coverage rate; for Americans aged 50 and above, their LTCI coverage rate ranged from 9% to 13% between 1996 and 2014.[2]

Brown and Finkelstein (2011) attributes the low LTCI coverage rate to supply-side barriers and factors constraining the demand for LTCI, including consumers' limited knowledge about the operation of LTCI policies and LTSS utilization risk. For example, AARP and the American Association for Long-term Care Insurance have explained on their websites that LTCI carriers deny coverage to applicants with pre-existing conditions. However, consumers may not know this practice. This lack of knowledge may adversely affect their demand for purchasing LTCI while they are healthy, and therefore prevent them from optimally planning for retirement. This paper uses pre-existing conditions in a broader sense, referring not only to doctor-diagnosed diseases, but also other ailments, specifically functional limitations and cognitive impairments,

[2] These percentages come from author calculation using the data from the Health and Retirement Study.

that lead LTCI carriers to deny applicants coverage. American Association for Long-Term Care Insurance (2017) suggests individuals with pre-existing conditions not fill out applications for LTCI. Of people in their 50s submitting applications, 14% were denied coverage (American Association for Long-Term Care Insurance 2017).

The challenge of assessing over a long horizon the risk of utilizing LTSS may have led individuals to stay in the status quo (i.e., not purchasing LTCI). When presented with a menu of LTCI options, individuals are informed of the stream of premiums they have to pay to claim benefits when becoming functionally- and/or cognitively-impaired. Yet, it may be challenging to evaluate the likelihood of becoming impaired because that may not happen for at least 15 years from the time of applying for LTCI; in 2012, the majority of people (54%) applied for LTCI at the age of 55-64, whereas most policyholders (66%) filed new claims after reaching 80 years old (American Association for Long-Term Care Insurance 2017).

To meet this challenge, studies have analyzed the risk of using a nursing home, a costly type of LTSS which may reach $6,750 per month (Genworth Financial 2016). For example, Hurd, Michaud and Rohwedder (2014) suggests that people in their 50s have an over 50% chance of entering a nursing home before they die. While these studies have contributed to the knowledge of LTSS risk, it may be difficult to use these findings to influence consumers' LTCI purchase decisions because these studies rarely take into account insurers' using individual information on health, functional, and cognitive status to determine LTCI coverage (i.e., underrwriting). As a result, findings from these studies may underestimate the LTSS risk faced by individuals ineligble for LTCI and consequently lead to undersaving for LTSS expenses.

To address this issue, this paper estimates the percentage of Americans potentially ineligible for LTCI due to pre-existing conditions, and analyzes how the lifetime likelihood of

using a nursing home responds to LTCI eligibility. The estimation uses underwriting guides from seven insurers and data from the Health and Retirement Study (HRS), notably information from disease follow-up questions. The findings show 36% of individuals aged 50-59 are high-risk, defined as having 1 or more pre-existing conditions which may prevent them from obtaining LTCI coverage. This percentage is more than double the application rejection rate reported by the LTCI trade association (36% versus 14%). This discrepancy may be explained by the latter being the rejection rate conditional on submitting an application, while the former is the ineligibility rate including both those discouraged from submitting an application and those uninterested in purchasing LTCI coverage. This ineligibility limits high-risk individuals' option to pay for LTSS. Meanwhile, it allows insurers to deter adverse selection.

This paper estimates the influence of pre-existing conditions on the lifetime likelihood of using a nursing home by constructing an analytical file to follow individuals aged 50-59 through the age of 96-105. The file construction is based on an approach similar to the methods for building cohort and period life tables. The estimation takes into account pre-existing conditions' two competing forces influencing the likelihood of using a nursing home: nursing home risk and mortality risk. These two forces predict pre-existing conditions elevate the likelihood of using a nursing home, and this elevation persists, yet diminishes as individuals age. Nursing home risk suggests that due to physical and mental limitations, high-risk individuals have a higher likelihood of using a nursing home conditional on being alive. Because high-risk individuals also face a higher mortality risk, this reduces their lifetime likelihood of using a nursing home.

The estimation is performed by using survival analysis. The results show that throughout the course of a lifetime, those with pre-existing conditions have a higher chance of entering a nursing home than those without. Specifically, the difference in the cumulative likelihood of

using a nursing home between those with and without pre-existing conditions increases from 0.7 percentage points at the age of 50-59, reaches 11.7 percentage points at the age of 70-79, stays steady through the age of 80-89, and declines to 8.7 percentage points at the age of 96-105. This pattern suggests pre-existing conditions have a lasting effect on elevating the likelihood of using a nursing home. Overall, the lifetime likelihood of using a nursing home is 41%-51% for individuals with pre-existing conditions at the age of 50-59. This likelihood is 32%-44% for their low-risk counterparts.

The findings can be used to enhance consumers' understanding of LTCI and the risk of using a nursing home. This enhancement may improve retirement planning, given that financial literacy affects planning behavior**.** The first finding shows a substantial percentage of individuals in their 50s are high-risk. This suggests the message (e.g., from AARP) that LTCI carriers deny coverage to applicants with pre-existing conditions can benefit a large fraction of the near elderly. Its further dissemination would help consumers with health problems understand LTCI may not be an option to pay for LTSS and consequently nudge them to explore other options, such as saving more to self-insure against the financial risk due to utilizing LTSS. The second finding shows the lifetime likelihood of using a nursing home for those with or without pre-existing conditions. This would help consumers more accurately assess the risk of using a nursing home and therefore reduce the likelihood of undersaving for LTSS expenses.

The rest of the paper is organized as follows. Section 2 reviews the literature. Section 3 describes underwriting practices in the LTCI market. Section 4 discusses the HRS data and estimates the percentage of Americans potentially ineligible for LTCI. Section 5 analyzes the influence of pre-existing conditions on the lifetime likelihood of using a nursing home. Section 6 concludes.

2. Literature Review

This paper contributes to three strands of the literature. First, a limited number of studies have estimated the percentage of Americans potentially ineligible for LTCI due to poor health (Murtaugh, Kemper, and Spillman 1995; Hendren 2013; Braun, Kopecky, and Koreshkova 2017). As described below, however, these studies may underestimate the ineligibility rate in current practices. An updated, more comprehensive analysis is needed. Murtaugh, Kemper, and Spillman (1995) uses the 1986 National Mortality Followback Survey and finds that between 12% and 23% of Americans aged 65 would be denied LTCI coverage due to poor health. The criteria used to simulate underwriting includes health service use, medical conditions, alcoholism, obesity, physical functioning measured by performing activities of daily living (ADLs), and mental functioning assessed by asking about Alzheimer's disease, organic brain disease, or senility. While the analysis closely follows underwriting practices at the time, this study may underestimate the ineligibility rate in current practices for two reasons. First, the LTCI underwriting has become stricter in the past twenty years (Singh 2016). For example, the study does not use instrumental activities of daily living (IADLs)[3] to measure physical functioning, but IADLs has become widely used in current practices. Additionally, the study does not use cognitive tests to measure mental functioning, but cognitive tests have been commonly adopted by insurers to screen out applicants with early-stage cognitive impairments (Society of Actuaries 2000). Second, since the subjects were already deceased at the time of the survey, this study uses a proxy (i.e., the next of kin or someone else familiar with the decedent) to collect a subject's

[3] ADLs are basic self-care tasks initially learned as very young children, while IADLs are self-care tasks usually learned as teenagers. IADLs require more complex thinking skills, including organizational skills. See Section 3.1 for the lists of ADLs and IADLs.

information on health service use, medical conditions, physical and mental functioning, and other attributes. The use of a proxy raises the question whether a subject's information was as accurately measured as the information reported by a subject him-/herself (Magaziner, et al. 1997; Li, Harris and Lu 2015).

Hendren (2013) uses the HRS data between 1993 and 2008 and insurers' underwriting guidelines to classify Americans aged 65 and above into three LTCI-eligibility groups: (1) rejection (27%); (2) uncertain (40%); (3) no rejection (33%). Individuals with any of the following conditions are classified into the "rejection" group: having difficulties with any ADL or IADL activities, past stroke, past nursing home or home care, and over the age of 80. Individuals with any of the following conditions are classified into the "Uncertain" group: lung disease, heart disease, current cancer, hip fracture, memory condition, and other major health problems. Since this study focuses on Americans aged 65 and above, it may be difficult to apply the findings to individuals in their 50s, who are at the prime age of purchasing LTCI and planning for retirement. In addition, it appears that this estimation does not fully utilize HRS questions about doctor-diagnosed medical conditions. HRS has introductory and follow-up questions about 8 common medical conditions. The use of introductory question alone requires looking at a disease as whole, making it uncertain when determining an individual's LTCI eligibility. In contrast, the use of follow-up questions enables finer distinctions within a disease, leading to a more precise classification of LTCI eligibility. For example, heart disease only utilizes the introductory question, "Has a doctor ever told you that you had a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems?" Answering "yes" leads to more than 10 follow-up questions about five heart conditions and procedures, including congestive heart failure, heart attack, angina, angioplasty, and heart surgery. If follow-

up questions were utilized, one could identify individuals who had congestive heart failure with one of the other four conditions and classify them as ineligible for LTCI. Heart disease alone may be insurable, but individuals with congestive heart failure and another heart condition or procedure are typically uninsurable.

Braun, Kopecky, and Koreshkova (2017) uses the HRS data and two insurers' underwriting guidelines and finds that the percentage of Americans aged 55-65 who would be ineligible for LTCI due to pre-existing conditions can reach 36%. This finding, however, may underestimate the ineligibility rate because it appears that their analysis does not take into account some commonly-used underwriting factors, such as body mass index (BMI), difficulties in performing IADLs, and cognitive impairments.[45]

Second, a number of studies have estimated the LTSS risk, although no studies have examined the association between LTSS risk and LTCI eligibility. Hurd, Michaud and Rohwedder (2014) and Friedberg, et al. (2014) thoroughly review studies estimating the lifetime risk of nursing home use. In particular, Hurd, Michaud and Rohwedder (2014) uses the HRS data from core and exit interviews and finds that individuals in their 50s have an over 50% chance of entering a nursing home before they die. Their estimate is higher than the results from prior studies, for example, Kemper and Murtaugh (1991) suggests that individuals aged 65 have a 43% chance of using nursing home before they die. Hurd, Michaud and Rohwedder (2014) attributes the higher estimate to the use of data from exit interviews after the last core interview because nursing home stay, generally short-term, may occur after the last core interview when

[4] Nevertheless, BMI, IADLs, and cognitive tests are included in their constructing a frailty index.

[5] Finkelstine and McGarry (2006) and Coe, Skira and Van Houtven (2015) also classify individuals into eligible for LTCI or not, although the ineligibility rate is not reported in these two studies.

respondents were alive, and these data capture such occurrences. However, Cutler (2014) comments that these occurences cannot fully explain the higher estimate because the data used by Kemper and Murtaugh (1991) probably also capture nursing home stays right before death. Cutler (2014) therefore seeks more clarification about this higher estimate. Brown and Finkelstein (2008) suggests that males (females) aged 65 without pre-existing conditions have a 27% (44%) chance of using a nursing home. However, it appears that this study does not analyze the likelihood for those with pre-existing conditions.

Third, a growing number of studies have attempted to explain the small LTCI market. The explanations include supply-side barriers, such as LTCI's high load factor (Brown and Finkelstein 2007) and poor product features (Ameriks, et al. 2016), and demand-side factors, including the crowing out effect of Medicaid (Brown, Coe and Finkelstein 2007; Brown and Finkelstein 2008), consumers' limited knowledge about the operation of LTCI policies and LTSS utilization risk, the imperfect substitutes for LTCI, such as informal LTSS provided by family members (Pauly 1990; Lakdawalla and Philipson 2002), and illiquid assets coming from home ownership (Davidoff 2010). Furthermore, the findings of Hendren (2013) suggest that the small LTCI market may be caused by private information possessed by high-risk individuals. This private information leads insurers to deny high-risk individuals coverage because if insurers offered any coverage to those who are currently denied, the offer would be too adversely selected to be profitable. My findings show that 36% of individuals aged 50-59 are high-risk, suggesting a substantial portion of the people at the prime age of purchasing LTCI may be excluded from the market. This exclusion may contribute to the small LTCI market.

3. Underwriting in the Long-Term Care Insurance Market

To deter adverse selection, LTCI insurers perform underwriting on applicants by evaluating their health, functional, and cognitive status. The results of underwriting are used to determine coverage and premium. I reviewed underwriting guides from seven insurers[6], five of which were top 10 LTCI carriers in 2015 (American Association for Long-Term Care Insurance 2016), and found that while insurers vary in their underwriting practices, these practices typically consist of three steps, outlined in Table 1. These steps are pre-qualification, application, and evaluation. Individuals failing pre-qualification are considered uninsurable; they are generally discouraged by insurance agents from submitting LTCI applications. Individuals passing pre-qualification proceed to fill out applications. Individuals applying for coverage in the individual market usually fill out applications with detailed questions about medical conditions and functional and cognitive status (i.e., long form). In the group market, some employees (e.g., new employees) can fill out applications with abbreviated questions (i.e., short form), while others fill out long-form applications.

[6] The seven LTCI insurers are Genworth Life Insurance Company, John Hancock Long-term Care Insurance, Massachusetts Mutual, MedAmerica Insurance Company, Mutual of Omaha Insurance Company, TransAmerica Life Insurance Company, and Sun Life Financial. These underwriting guides are obtained by internet searches, for example, "underwriting guideline for long-term care insurance." These guides are usually for insurance agent use only, but are available to the public.

Table 1: Long-Term Care Insurance Underwriting

Step	Procedure
1	Pre-qualification – Age – Height and Weight – Pre-existing Conditions • Functional Limitations • Cognitive Impairments • Medical Conditions • Prescription Drug Use • Use of LTSS • Recipient of Social Security Disability Insurance Benefits
2	Application – Long Form – Short Form
3	Evaluation – Ordering Medical Records Including Prescription Drug Use – Inquiring to the Medical Information Bureau – Interview • Younger Applicants with Doctor Visits within a Time Frame ▪ Phone Interview • Younger Applicants without Doctor Visits with a Time Frame ▪ In-Person Interview • Older Applicants ▪ In-Person Interview

1. Insurers use slightly different cutoff ages to define younger and older applicants. Commonly-used cutoff ages include 65, 69, and 70.

2. Insurers use slightly different time frames to determine whether to conduct interviews with younger applicants by phone or in-person. Commonly-used time frames include two years or 18 months.

3.1 Pre-qualification

Pre-qualification in the documents reviewed consists of three elements: age, height and weight, and pre-existing conditions. Insurers typically do not issue coverage to individuals older than a certain age, though this cutoff age varies across insurers (e.g., 75, 79, or 85). Individuals not meeting height and weight requirements are considered uninsurable, though the requirements slightly vary across insurers. Some insurers do not issue coverage to an underweight individual with body mass index (BMI) lower than 17, while some set the cutoff BMI value at 19. Some insurers deny coverage to an obese individual with BMI greater than 39.9, while some set the cutoff BMI value at 40 for males and 38 for females.

Agents are instructed to discourage individuals from applying for LTCI coverage if they have any pre-existing conditions, including functional limitations, cognitive impairments, medical conditions, and prescription drug use. Functional limitations refer to the need for assistance with activities of daily living (ADLs) and/or instrumental activities of daily living (IADLs). Six ADLs are listed as uninsurable conditions by most insurers; they are dressing, bathing, eating, getting in or out of bed, toileting, and continence.[7] IADLs refer to activities requiring higher levels of functional capability than ADLs. The list of uninsurable IADLs varies across insurers, though the following IADLs are often listed: taking medications, using the telephone, managing finance, shopping, meal preparation, housekeeping, and laundry.

Cognitive impairments refer to memory loss or having been diagnosed with memory-related diseases, such as dementia or Alzheimer's disease. The symptoms range from mild (e.g.,

[7] The use of a wheelchair, walker, or cane is typically considered as uninsurable. In HRS, only respondents having difficulties with dressing are asked whether they ever use a wheelchair, walker, or cane. Therefore, the possibility of this use is assumed to have been included in the affirmative answer to the question about difficulties with dressing.

diminished judgment), moderate (e.g., needing assistance for ADLs), to severe (e.g., bedridden). Cognitive impairments are considered uninsurable by virtually all insurers because they are a major driver of LTCI claims costs; cognitive impairments account for over 30% of newly-approved LTCI claims and nearly 40% of ongoing LTCI claims lasting for 24 months (Society of Actuaries 2014).

Cognitive tests are commonly used by insurers to screen out applicants with early-stage cognitive impairments because their symptoms are rarely noted in medical records. These tests measure a variety of capabilities, including memory, knowledge, language, and orientation.[8] Insurers vary in their cutoff test scores used to deny coverage. Cognitive tests are usually required for applicants aged 65 and above, though some insurers require the tests for applicants aged 50 and above.

Most insurers list uninsurable medical conditions and discourage individuals with any of these conditions from applying for LTCI. This list is comprehensive and varies across insurers. It is beyond the scope of this paper to list all of the uninsurable medical conditions. Alternatively, I show below commonly-listed uninsurable medical conditions observed in the publicly-available HRS data.[9]

- High blood pressure, BMI greater than 35, and tobacco use
- Chronic obstructive pulmonary disease (COPD) with oxygen or tobacco use
- Diabetes treated with insulin or with a history of heart disease or tobacco use

[8] Examples of commonly-used cognitive tests include the Minnesota Cognitive Acuity Screen (MCAS), the Enhanced Mental Skills Test (EMST), and the Short Portable Mental Status Questionnaire (SPMSQ). These three tests measure similar capabilities.

[9] Conditions described earlier, such as Alzheimer's disease, are not repeated in this list.

- Heart disease with tobacco use; hospitalized congestive heart failure; congestive heart failure with heart attack, angina, angioplasty, heart surgery
- Stroke
- Cancer: currently treated with chemotherapy or radiation, spreading to multiple locations, or 2 or more cancers
- Osteoarthritis or rheumatoid arthritis limiting activities
- Joint replacement: 2 or more
- Fall: 3 or more in the past two years
- Major mental illness treated with antipsychotic medications or hospitalization
- Alcohol use with 4 or more drinks daily

Individuals with uninsurable medical conditions are often treated with prescription drugs. As a result, most insurers list prescription drugs associated with uninsurable medical conditions and discourage individuals taking any of these prescription drugs from applying for LTCI. Virtually all insurers deny coverage to individuals currently receiving Social Security Disability Insurance (SSDI) benefits, currently using LTSS, or having used LTSS in the past 6 months or a year.

3.2 Application

Individuals passing pre-qualification can proceed to fill out applications. Individuals applying for coverage in the individual market usually fill out applications with detailed questions about medical conditions and functional and cognitive status (i.e., long form). In the group market, some employees can fill out applications with abbreviated questions (i.e., short form), while others fill out long-form applications. For example, the federal long term care

insurance program,[10] a large employer-sponsored plan, only allows individuals meeting the following requirements to fill out short-form applications.[11]

- In one of the following groups:
    1) New or newly eligible employee
    2) Spouse of a new or newly eligible employee
    3) Newly married spouse of an eligible employee
- Applying within 60 days of becoming eligible to apply

All other eligible individuals must fill out long-form applications.[12]

Both versions of the application include health questions to screen out those with pre-existing conditions; they are instructed not to complete the rest of the application. Additionally, both versions of the application ask applicants to authorize insurers to access any information on their health, functional, and cognitive status from any entity, such as licensed health care practitioners, medical facilities, employers, insurance companies, and the Medical Information Bureau (MIB). MIB is a member-owned organization providing information exchange for its members, life and health insurance companies offering life, health, disability income, and/or LTCI policies. MIB's member insurers contribute their applicants' information collected during the underwriting process to the MIB database. Later, when these applicants apply for additional policies to other member insurers, these insurers can inquire from the MIB about their prior insurability to support the underwriting of additional policies.

[10] The federal long term care insurance program is sponsored by the U.S. Office of Personnel Management, offered by John Hancock Life & Health Insurance Company, and administered by Long Term Care Partners, LLC.

[11] https://www.ltcfeds.com/epAssets/documents/abb_underwriting_app.pdf

[12] https://www.ltcfeds.com/epAssets/documents/full_underwriting_app.pdf

3.3 Evaluation

Insurers determine LTCI coverage and premium based on information provided in the application and additional information collected from the following three actions:

- Ordering applicants' medical records including prescription drug use from their physicians, if visited within a time frame (e.g., the past two years)
- Inquiring from the MIB about the applicants' prior insurability
- Conducting interviews

The type of interview depends on an applicant's age and the time of his or her last doctor visit. Phone interviews are typically conducted with applicants younger than the cutoff age (e.g., 69) and having doctor visits within a time frame (e.g., the past two years). Phone interviews, conducted by nurses, include questions about ADLs, medical history, symptoms, prescription drug use, and lifestyle. Cognitive assessments are included in the phone interviews if applicants are aged 65 and above or have certain medical conditions. Phone interviews usually take 30 minutes.

In-person interviews are usually conducted with applicants older than the cutoff age (e.g., 69) and those younger than the cutoff age, yet not having doctor visits within a time frame (e.g., the past two years). In-person interviews, conducted at applicants' homes by nurses, include cognitive assessments, measurements of blood pressure, height, and weight, and questions about ADLs, medical history, symptoms, prescription drug use, and lifestyle. In-person interviews usually take 45 minutes.

4. Percentage of Americans Ineligible for Long-Term Care Insurance

This paper uses data from the Health and Retirement Study (HRS) between 1998 and 2012 to estimate the percentage of Americans over 50 potentially ineligible for LTCI, and analyze how the likelihood of utilizing LTSS responds to LTCI eligibility. HRS, a nationally representative panel survey of Americans over 50, is the best available data set to study these questions because its respondents are at the prime age of applying for LTCI. HRS makes it feasible to approximately classify respondents into eligible for LTCI or not, because it has a series of survey questions about functional status, cognitive ability, and doctor-diagnosed diseases. HRS has introductory and follow-up questions about 8 diseases, including: hypertension; diabetes; cancer; lung disease; heart disease; stroke; psychiatric problems; and arthritis. An introductory question asks a respondent whether he or she is diagnosed with the disease. Answering "yes" leads to follow-up questions about symptoms, treatment, and forms of disease. These follow-up questions enable finer distinctions within a disease and therefore play an important role in determining an individual's LTCI eligibility; the diagnosis of a disease alone may not suggest sufficient risk to be uninsurable, yet the diagnosis associated with a particular treatment or condition may suggest a higher risk, leading to uninsurability. For example, HRS asks not only whether a respondent has been diagnosed with diabetes, but also whether a diabetic is under insulin treatment. This follow-up information is important because diabetes alone may still be insurable, but diabetes with insulin treatment is listed as uninsurable in all of the underwriting guides reviewed.

The time frame of 1998 and 2012 is selected because 1998 is the first year when HRS collected information on memory-related disease. Since identifying individuals with cognitive impairments is crucial in LTCI underwriting, an analysis of LTCI ineligibility without

information on memory-related disease is hardly ideal. 1998 is also the first year when the HRS and AHEAD[13] cohorts were fully integrated, and the year when two cohorts[14] were added to the survey. This integration and addition make the HRS sample nationally representative of Americans over 50. Some survey questions prior to 1996 are inconsistent with questions in later waves. For example, respondents were asked about different IADL questions in 1992 and 1994 than in the rest of the years. In 2014, HRS no longer asked respondents with arthritis whether arthritis limited their usual activities. The inadequacy of follow-up questions about arthritis makes the 2014 data less suitable for estimating the LTCI ineligibility rate. Arthritis is the leading cause of disability and one of the most common chronic conditions. Arthritis alone may be insurable, but arthritis limiting usual activities is virtually uninsurable.

4.1 Data Description

Table 2 shows the publicly-available HRS variables used to assess a respondent's LTCI eligibility. This assessment is close to pre-qualification, step 1 of the underwriting practices, described in Section 3.1. These variables include age, height and weight, functional status, cognitive ability, medical conditions, lifestyle, and SSDI. Functional status variables consist of 12 binary variables on six ADLs and six IADLs. The six ADLs are dressing, bathing, eating, getting in or out of bed, toileting, and continence. The six IADLs are taking medications, using the telephone, managing money, shopping for groceries, preparing hot meals, and doing housework.

[13] The HRS cohort was born between 1931 and 1941. The AHEAD cohort was born before 1924, initially in a separate study (The Study of Assets and Health Dynamics Among the Oldest Old).

[14] These two cohorts are Children of Depression (CODA) cohort, born between 1924 and 1930, and War Baby (WB) cohort, born between 1942 and 1947.

Table 2: HRS Variables Used to Assess Eligibility for Long-Term Care Insurance

Category	Variable
	Age
	Height and Weight
Functional Status	
• ADLs	(1) Dressing; (2) Bathing; (3) Eating; (4) Getting in or out of Bed; (5) Toileting; (6) Continence
• IADLs	(1) Taking Medications; (2) Using Telephone; (3) Managing Money; (4) Shopping for Groceries; (5) Preparing Hot Meals; (6) Doing Housework
Cognitive Ability	
• Disease	Memory-Related Disease (Dementia; Alzheimer's Disease)
• Cognitive Test	
▪ Self	(1) Immediate Word Recall; (2) Delayed Word Recall; (3) Serial 7's; (4) Backwards Counting; (5) Date Naming; (6) Object Naming; (7) President and Vice-President Naming
▪ Proxy	Memory Rating
Medical Conditions	(1) High Blood Pressure; (2) Diabetes and Insulin Use; (3) Heart Disease (Congestive Heart Failure, Angina, Heart Attack, Angioplasty, or Heart Surgery); (4) Stroke; (5) Chronic Lung Disease with Oxygen Use; (6) Cancer (Number, Treatment, and Spreading); (7) Arthritis or Rheumatism (Treatment and Activity Limitation); (8) Joint Replacement (Number); (9) Fall (Number and Severity)
Lifestyle	Currently Smoking Drinking (Frequency and Amount)
SSDI	Receiving SSDI Benefits

1. ADL refers to activity of daily living, and IADL refers to instrumental activity of daily living.

2. Self refers to respondents taking the cognitive tests by themselves. Proxy indicates that the cognitive tests are conducted with proxy respondents.

Cognitive ability variables consist of binary variables of memory-related disease and results from cognitive tests. From 1998 to 2008, respondents were asked if they had ever been told by a doctor they had a memory-related disease. This question has been modified since 2010; respondents are now asked if they have been told they have Alzheimer's disease or dementia.

HRS's cognitive test evaluates a respondent's memory, knowledge, language, and orientation (Ofstedal, Fisher and Herzog 2005; Fisher, et al. 2015). For a respondent asked to participate in the entire test, their scores range from 0 to 35. A score less than 9 is considered an indication of dementia or severe cognitive impairment (Herzog and Wallace 1997). Memory is assessed by immediate word recall, delayed word recall, and the Serial 7's subtraction test, in which a respondent is asked to subtract 7 from 100, and continue subtracting 7 from each subsequent number for a total of five trials. Knowledge, language, and orientation are assessed by backward counting from 20 and 86, date naming, object naming, and president and vice-president naming. The entire cognitive test was administered to all respondents in 1996. From 1998 to 2012, the entire cognitive test was administered only to respondents aged 65 and above and new respondents in a given wave; re-interviewed respondents under the age of 65 were not asked about date naming, object naming, and president and vice-president naming. Like other HRS survey questions, the cognitive test is administered in person to new respondents, and by phone to re-interviewed respondents.

Due to physical or cognitive problems, 7% of the respondents could not participate in the cognitive tests by themselves; their cognitive status was assessed by an alternative set of questions answered by their proxies. This alternative is needed because the aforementioned assessment cannot be conducted with proxy respondents. This alternative includes a question asking proxies to rate respondents' memory on a five-level scale: excellent, very good, good,

fair, and poor. A poor rating is considered an indication of severe cognitive impairment (Freedman, Aykan and Martin 2001).[15]

Variables on medical conditions show whether a respondent has been diagnosed with a certain disease, as well as its symptoms, treatment, and forms of disease. These variables, obtained from the public HRS data, include

- High blood pressure
- Diabetes with insulin use
- Heart disease with conditions and procedures (congestive heart failure, heart attack, angina, angioplasty, and heart surgery)
- Stroke
- Chronic lung disease with oxygen use
- Cancer (number, treatment, and spreading)
- Arthritis and rheumatism (treatment and activity limitation)
- Joint replacement (number)
- Fall (number and severity) for respondents aged 65 and above

Lifestyle variables consist of a binary variable on currently smoking and two categorical variables on the frequency (number of days per week) of drinking alcoholic beverages and the number of drinks on the days of drinking. The SSDI variable is binary indicating whether the respondent is receiving SSDI benefits or not.

[15] This alternative also includes a question asking proxies to rate respondents' judgment on a five-level scale. This question is used to define severe cognitive impairment in Freedman, Aykan, and Martin (2001). This question, however, is not used in this paper because it disappeared in 2004 and later waves.

4.2 Estimates of the LTCI Ineligibility Rate

The analysis sample includes non-institutionalized individuals aged 50 to 79 in 1998, divided into three age groups: 50-59, 60-69, and 70-79. Respondents over 80 are excluded from the analysis because most insurers do not offer coverage to individuals over 80. Table 3 reports their demographic characteristics, functional status, cognitive ability, and health conditions. When reporting results, I focus on the group aged 50-59 because their lifetime likelihood of using a nursing home is estimated in the next section. Concerning this group, 48% were male, 85% were Caucasians, 8% were Hispanics, and 16% did not have a high school diploma. Two percent were extremely underweight (BMI<19), while 3% were obese (BMI ≥40). Thirteen percent had difficulties with 1 or more ADLs. This percentage reached 23% for individuals aged 70-79. Dressing was the most common ADL that individuals had difficulties with, while eating was the least common. Fifteen percent of the individuals aged 50-59 had difficulties with 1 or more IADLs. Individuals aged 70-79 had more than twice this share (32%). Working around the house or yard was the most common IADL that individuals had difficulties with, while taking medications and using telephone were the two least frequent. Two percent of the individuals aged 50-59 had cognitive disorders. This percentage doubled for individuals aged 70-79. Being diagnosed with a memory-related disease was a more common classification of cognitive disorders than failing a cognitive test. Twenty-four percent of individuals aged 50-59 had at least one uninsurable medical condition. This percentage reached 43% for individuals aged 70-79. Arthritis limiting usual activities is the most common uninsurable medical condition, consistent with the fact that arthritis is the leading cause of disability. Approximately 1% of the individuals were alcoholic, defined as 4 or more drinks daily. Five percent of the individuals aged 50-59 were receiving Social Security Disability Insurance (SSDI) benefits at the time of interview. This

Table 3: Percentage of Individuals Ineligible for LTCI (i.e., High-Risk Individuals) in 1998

	Age Group		
	[1] 50-59	[2] 60-69	[3] 70-79
Number of HRS Respondent	6,091	6,713	4,995
Average Age	54.4	64.3	74.1
Male (%)	47.6	46.1	42.8
Race (%)			
Whites	85.6	86.7	89.6
Blacks	10.0	9.7	7.9
Hispanics (%)	7.5	6.4	4.6
Education			
Less than High School	15.8	24.5	31.0
High School	35.9	38.1	36.0
Some College	24.3	18.4	17.7
College and Above	24.1	19.0	15.4
BMI (%)			
< 19	**1.8**	**1.7**	**3.9**
≥ 40	**3.4**	**2.2**	**0.9**
Having Difficulty with ADL (%)			
Dressing	5.6	7.3	10.5
Bathing	3.2	4.5	7.9
Eating	1.3	2.0	3.3
Getting in or out of Bed	5.3	5.4	5.5
Using Toilet	3.1	3.6	6.2
Continence	5.0	7.0	10.3
Having Difficulty with One or More ADLs (%)	**13.4**	**16.7**	**23.4**
Having Difficulty with IADL (%)			
Taking Medications	1.8	1.8	3.3
Using Telephone	1.6	2.2	5.1
Managing Money	2.7	2.8	6.1
Shopping for Groceries	5.1	5.7	10.0
Preparing Hot Meals	2.6	3.3	7.0
Working Around House or Yard	11.6	16.0	25.5
Having Difficulty with One or More IADLs (%)	**15.2**	**19.9**	**31.9**
Cognitive Disorder (%)			
Memory-Related Disease	1.1	1.0	2.3
Cognitive Test			
Self: Score ≤ 8	0.3	0.3	1.3
Proxy: Poor Memory	3.6	6.9	18.8
One or More Cognitive Disorders (%)	**1.5**	**1.6**	**3.7**

Table 3: Percentage of Individuals Ineligible for LTCI (High-Risk Individuals) in 1998 (Continued)

	Age Group		
	[1] 50-59	[2] 60-69	[3] 70-79
Diagnosed with Medical Conditions (%)			
HBP, BMI>35, and Smoking	0.7	0.3	0.03
COPD with Oxygen Use or Smoking	2.0	3.2	3.1
Diabetes with Insulin, HD, or Smoking	4.9	7.0	9.1
HD with Smoking or Specific Conditions	3.3	4.2	5.9
Stroke	2.8	5.0	9.8
Cancer with Treatment	1.3	2.0	3.6
Arthritis Limiting Activities	15.1	19.8	22.1
Joint Replacement (2 or More)	0.3	0.7	1.8
Falls (3 or More in Past 2 Years)	N/A	4.4	6.6
One or More Medical Conditions (%)	**23.5**	**32.5**	**42.7**
Alcoholism (%)	1.4	1.4	0.9
Receiving SSDI	4.8	5.2	0.9
High-Risk (%)	**36.4**	**45.7**	**59.4**

1. Average age and all of the percentages are weighed by person-level weights applying to those living in the community; weights are 0 for those living in a nursing home at the time of interview.

2. One or more cognitive disorders refers to having been diagnosed with memory-related disease, test score not greater than 8 (self respondents), or memory rated as poor (proxy respondents).

3. HBP refers to high blood pressure; COPD refers to chronic obstructive pulmonary disease.

4. HD refers to heart disease; "HD with Smoking or Specific Conditions" refers to (1) heart disease with current smoking; (2) hospitalized congestive heart failure in the past two years; (3) congestive heart failure with heart attack, angina, angioplasty; or heart surgery in the past two years.

5. "Cancer with Treatment" refers to cancer currently treated, spreading to multiple locations, or 2+ cancers.

6. Questions about falling down are administered only to respondents aged 65 and above.

7. Alcoholism refers to alcohol use with 4 or more drinks daily.

8. High-risk is defined as meeting 1 or more of the following 7 criteria: (1) BMI <19 or >=40; (2) having 1 or more ADLs; (3) having 1 or more IADLs; (4) having 1 or more cognitive disorders; (5) diagnosed with 1 or more medical conditions; (6) alcoholism; (7) receiving Social Security Disability Insurance (SSDI) benefits.

percentage was 1% for individuals aged 70-79. This lower percentage is consistent with the operation of SSDI; candidates for SSDI must be younger than 65, and SSDI benefits are automatically converted to retirement benefits when the recipient reaches full retirement age.

Overall, 36% of the individuals aged 50-59 are considered high-risk because they met 1 or more of the 7 exclusion criteria commonly used by insurers to discourage people from applying for LTCI. This percentage is 46% and 60%, respectively, for individuals aged 60-69 and 70-79. The 7 exclusion criteria are (1) BMI<19 or ≥40; (2) having difficulties with 1 or more ADLs; (3) having difficulties with 1 or more IADLs; (4) 1 or more cognitive disorders; (5) 1 or more medical conditions; (6) alcoholism; (7) receiving SSDI benefits.

Impact of Using HRS Disease Follow-Up Questions

As described earlier, one contribution of this paper is utilizing HRS follow-up questions about doctor-diagnosed diseases to classify individuals into potentially eligible for LTCI or not. This contribution is shown in Table 4, which uses three diseases (heart disease, cancer, and arthritis) to illustrate the impact of using follow-up questions on the LTCI ineligibility rate. Panel 1 uses only disease introductory questions to estimate the ineligibility rate. An introductory question asks whether the respondent has a disease or not, and follow-up questions elicit information on symptoms, treatment, and forms of disease. Having a disease alone may still be insurable because insurers take into account disease severity and treatment to assess the risk of claiming LTCI benefits. Therefore, classifying individuals into high-risk based on information from introductory questions is inconsistent with insurers' underwriting practices, and may overestimate the LTCI ineligibility rate. This inconsistency is addressed in Hendren (2013), which uses HRS disease introductory questions to classify the LTCI eligibility status of

Table 4: Impact of Using HRS Disease Follow-Up Questions on High-Risk Rate in 1998

	Age Group		
	[1] 50-59	[2] 60-69	[3] 70-79
Panel 1: Using Disease Introductory Questions Only			
Heart Disease (HD)	9.5	17.5	27.7
Cancer	5.4	9.7	14.2
Arthritis	34.3	50.7	53.2
High-Risk	**52.5**	**70.2**	**79.3**
Panel 2: Excluding These Three Diseases			
High-Risk	**30.0**	**38.1**	**52.4**
Panel 3: Using Disease Follow-up Questions			
HD with Smoking or Specific Conditions	3.3	4.2	5.9
Cancer with Treatment	1.3	2.0	3.6
Arthritis Limiting Activities	15.1	19.8	22.1
High-Risk	**36.4**	**45.7**	**59.4**

1. Numbers reported are percentages.

2. Numbers reported in Panel 3 are the same as those in the corresponding rows in Table 3.

3. The rest of the pre-qualification criteria are the same as those described in Table 3.

individuals with diseases as "uncertain." For illustrative purposes, Panel 1 reports the prevalence of heart disease, cancer, and arthritis, and the LTCI ineligibility rate when individuals with any of these diseases, or meeting the other exclusion criteria, are classified as high-risk. Of individuals aged 50-59, 10% were diagnosed with heart disease, 5% with cancer, and 34% with arthritis. The percentage of high-risk individuals amounts to 53% when individuals with any of these three diseases, or meeting the other exclusion criteria in Table 3, are considered uninsurable.

In Hendren (2013), none of these three diseases is used in classifying an individual's LTCI eligibility status as "rejection." Insurers do consider these three diseases in underwriting so excluding them from determining the status of rejection may underestimate the LTCI ineligibility rate. To illustrate this underestimation, Panel 2 reports the LTCI ineligibility rate when excluding these three diseases from the criteria. Of individuals aged 50-59, the ineligibility rate is now 30%, a 23-percentage-point decline from Panel 1.

Neither of the approaches used in Panel 1 and 2 is ideal because neither utilizes HRS disease follow-up questions, which provide information on symptoms, treatment, and forms of disease. This utilization enables me to more closely follow insurers' underwriting practices at the pre-qualification stage, and hence more precisely estimate the LTCI ineligibility rate. Answering "yes" to the introductory question of arthritis leads to a series of follow-up questions, one of which is "Does your arthritis sometimes limit your usual activities?" This question is crucial because it enables identification of respondents whose arthritis limits usual activities, and this identification leads to classifying them as uninsurable. Wilkin, Hileman and Genuardi (2007) indicates arthritis alone is insurable, but arthritis limiting activities is virtually uninsurable because it leads to a substantially higher rate of LTCI claims.

Likewise, cancer alone may be insurable because underwriters assess the risk by considering various aspects of cancer, such as site, stage, number, treatment, and spreading to other locations. The publicly-available HRS data do not include information on cancer site, and HRS does not solicit information on the stage of cancer. Nevertheless, the follow-up questions provide information on cancer treatment,[16] number of cancer,[17] and spreading.[18] These questions

[16] This question is "During the last two years, what sort of treatments have you received for cancer?"

[17] This question is "How many different cancers have you had?"

enable identification of respondents with currently-treated cancer, cancer that has already spread, or 2 or more cancers. This identification leads to classifying them as high-risk; these three cancer conditions are typically uninsurable.

The prevalence of these three diseases' uninsurable conditions, identified by disease follow-up questions, is already reported in Table 3. For ease of comparison, I copied their prevalence to Panel 3. This panel shows that of individuals aged 50-59, 3% had uninsurable conditions of heart disease, a 7-percentage-point decline from the 10-point prevalence of heart disease. These uninsurable conditions are (1) heart disease with current smoking, (2) hospitalized congestive heart failure in the past two years, or (3) congestive heart failure with heart attack, angina, angioplasty, or heart surgery in the past two years.[19] One percent had uninsurable conditions of cancer, a 4-percentage-point decline from the 5-point prevalence of cancer. These uninsurable conditions are currently-treated cancer, cancer spreading to multiple locations, or two or more cancers. Fifteen percent had arthritis limiting activities, a 19-percentage-point decline from the 34-point prevalence of arthritis.

The percentage of high-risk individuals is 36% when being high-risk is defined as having any of these three diseases' uninsurable conditions or meeting the other exclusion criteria. This percentage is a 17-percentage-point drop from the high-risk percentage reported in Panel 1 using disease introductory questions only, yet a 6-point increase from the high-risk percentage reported in Panel 2 excluding these three diseases from the criteria. The findings suggest utilizing HRS disease follow-up questions has a substantial impact on estimating the LTCI ineligibility rate. Since this utilization more closely follows insurers' underwriting practices than the other two

[18] This question is "Has your cancer/Have any of your cancers spread?"

[19] The follow-up questions about heart disease are described in Section 2.

approaches, this suggests the utilization improves estimation, and the estimate (36%) is closer to the true LTCI ineligibility rate than the estimates reported in the other two panels.

Impact of Varying Underwriting Criterion

Table 3 utilizes commonly-used underwriting criteria to estimate the LTCI ineligibility rate. The estimate is representative. Still, since insurers vary in their underwriting practices, I conduct a sensitivity analysis in Table 5 to examine how the estimate responds to change in an underwriting criterion. Column [2] is the benchmark, whose underwriting criteria are identical with those in Table 3. In each of the other columns, one criterion is deviated from those in Column [2]. Column [1] deviates from [2] because it removes IADLs from the criteria. Of individuals aged 50-59, this removal leads to a 3-percentage-point decline in the LTCI ineligibility rate (33.4% versus 36.4%). This removal is examined because while having difficulties with 1 or more IADLs is a widely-used criterion, IADLs are not mentioned in one insurer's (out of seven) reviewed underwriting guideline, nor in Braun, Kopecky and Koreshkova (2017).

Column [3] deviates from [2] because it adds the use of LTSS in the past two years to the criteria.[20] Of individuals aged 50-59, this addition leads to a 0.4-percentage-point increase in the LTCI ineligiblity rate (36.8% versus 36.4%). This addition is examined because many insurers deny coverage to past use of LTSS, within a window of 6 months or 1 year. This window is shorter than HRS's two-year window for nursing home stay and home care use. Therefore, Table 3 does not include the use of nursing home or home care in the past two years as an underwriting criterion, to avoid overestimation, yet results in a slight underestimation of the LTCI ineligiblity

[20] The LTSS variables consist of two binary variables on using nursing home and home care in the past two years.

Table 5: Impact of Varying Underwriting Criterion on High-Risk Rate in 1998

	Pre-qualification Criteria (from Loose to Tight)					
	[1]	[2]	[3]	[4]	[5]	[6]
		Table 3				
Variation in Underwriting Criterion						
1. IADLs						
▪ 6 IADLs		√	√	√	√	√
▪ Excluding Any IADL	√					
2. LTSS Use						
▪ Excluding LTSS Use	√	√		√	√	√
▪ Nursing Home or Home Care in Past 2 Years			√			
3. Psychiatric Problems						
▪ Excluding Psychiatric Problems	√	√	√		√	√
▪ Treated by Therapy and Medications				√		
4. Arthritis						
▪ Limiting Activities	√	√	√	√		√
▪ Limiting Activities or Treated by Doctors with Medications or Therapy					√	
5. Incontinence						
▪ 5+ Days in the Month before Interview	√	√	√	√	√	
▪ Losing Any Amount of Urine in Past 12 Months						√
Percentage of High-Risk by Age Group						
50-59	33.4	**36.4**	36.8	37.0	38.1	39.6
60-69	41.9	**45.7**	46.4	46.1	47.9	49.1
70-79	52.9	**59.4**	61.1	59.6	61.6	62.2

1.The check mark means that criterion is applied in estimating the percentage of high-risk individuals.

2. Column [4] corresponds to the criteria and percentages reported in Table 3. In each of the other columns, one criterion is deviated from the criteria used in Table 3. For example, Column [1] deviates from [4] because it no longer uses IADL in the exclusion criteria.

rate. All insurers deny coverage to current users of LTSS. The analysis sample in Table 3 only includes non-institutionalized indivdiuals, excluding individuals currently staying in a nursing home.

Column [4] deviates from [2] because it adds psychiatric problems treated with therapy and medications[21] to the criteria. Of individuals aged 50-59, this addition leads to a 0.6-percentage-point increase in the LTCI ineligibility rate (37.0% versus 36.4%). This addition is examined because insurers typically deny coverage to individuals with major mental illness (bipolar disorder, major depression, or schizophrenia) treated by hospitalization or antipsychotic medications, yet HRS-provided information on psychiatric problems and treatment is not specific enough to identify individuals with major mental illness, or the type of treatment or medication. Therefore, Table 3 does not include psychiatric problems treated with therapy and medications as an underwriting criterion, to avoid overestimation, yet results in a slight underestimation of the LTCI ineligibility rate.

Column [5] deviates from [2] because it narrows the arthritis criterion to be "arthritis limiting activities or treated by doctors with medication or therapy." This tightened criterion leads to a 1.7-percentage-point increase in the LTCI ineligiblity rate (38.1% versus 36.4%). This tightened criterion is examined because while virtually all insurers consider arthritis limiting activities as uninsurable, some also consider arthritis treated with narcotic medications, steroidal injections, or physical therapy as uninsurable. HRS has a follow-up question about current arthritis medication or treatments, which does not specify the type of medication or treatments.[22]

[21] The variable on psychiatric problems treated with therapy and medications is binary, derived from two follow-up questions, "Do you now get psychiatric or psychological treatment for your problems?" and "Do you now take tranquilizers, antidepressants, or pills for nerves?

[22] The question is "Are you currently taking any medication or other treatments for your arthritis or rheumatism?"

Column [6] deviates from [2] because it restricts one of the ADL criteria by broadening the definition of incontinence from "losing urine for 5 or more days in the month before the interview" to "losing any amount of urine in the past 12 months." This broader definition leads to a 3.2-percentage-point increase in the LTCI ineligiblity rate (40.4% versus 37.3%). This broader definition is examined because HRS offers two ways to measure incontinence, whose narrower definition is used in Table 3 to avoid overestimation of the LTCI ineligiblity rate, yet it appears that the broader definition is used in Finkelstine and McGarry (2006).

Influence of Demographics on High-Risk Rate

To idenify vulnerable groups, I examine in Table 6 how the high-risk rate varies by gender, education, and race and ethnicity. The underwriting criteria in Table 6 are identical with those in Table 3. Of individuals aged 50-59, 32% of the males may be discouraged from applying for LTCI coverage. This percentage was higher (40%) for the females. This gender gap persisted, yet diminished with aging (8 points in the 50s, but only 4 points in the 70s). Further analysis shows that across the three age groups, this gender gap appeared in the domains of BMI, ADL, IADL, and arthritis limiting usual activities, consistent with the fact that men have a lower rate of doctor-diagnosed arthritis than women (Barbour, et al. 2017).

Of individuals aged 50-59, 53% of the people lacking a high school diploma were high-risk, whereas 23% of the people with a college degree and above were high-risk. This difference suggests more education is associated with a lower LTCI ineligiblity rate. This association is fairly consistent across the three age groups. Further analysis shows this association appeared in many domains, but not cancer or alcoholism.

Table 6: Percentages of High-Risk Individuals in 1998, Stratified by Demographics

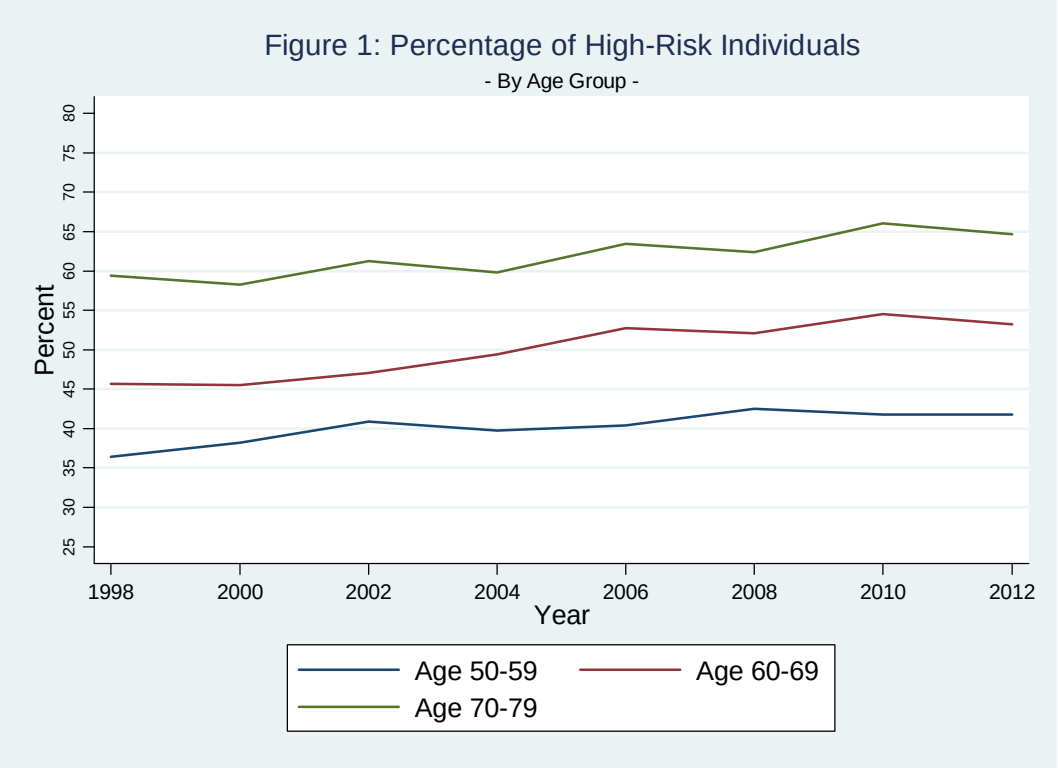
	Age Group		
	[1] 50-59	[2] 60-69	[3] 70-79
Gender (%)			
Male	32.1	43.0	57.2
Female	40.4	48.0	61.1
Education (%)			
Less than High School	53.4	59.2	66.9
High School	37.4	46.1	57.6
Some College	37.4	39.1	60.0
College and Above	22.9	33.9	47.7
Race & Ethnicity (%)			
Hispanics	37.6	52.2	59.4
Non-Hispanic Whites	34.6	44.0	58.6
Non-Hispanic Blacks	47.5	54.8	70.0

1. See Table 3 for the underwriting criteria used in estimating percentages of high-risk individuals.

Of individuals aged 50-59, 48% of the non-Hispanic blacks were high-risk. This percentage was 38% and 35%, respectively, for Hispanics and non-Hispanic whites. Across the three age groups, non-Hispanic blacks were more likely to be high-risk than the other two race and ethnicity groups. Further analysis shows that extreme BMI values, having difficulites with IADLs, and doctor-diagnosed diseases were more common among non-Hispanic Blacks than the other two groups.

Trend of High-Riak Rate from 1998 to 2012

A cross-sectional analysis is conducted to show the trend of high-risk rate from 1998 to 2012 in Figure 1. The percentage of being high-risk slightly increased over time. Of individuals aged 50-59, the high-risk percentage increasesd from 36.4% in 1998, to 42.5% in 2008. This trend is consistent with a small increase in average age, from 54.4 in 1998 to 56.7 in



2008. The composition of HRS cohorts differed across years. From 1998 to 2002, virtually all respondents aged 50-59 came from the initial HRS and War Baby (WB) cohorts. The Early Baby Boomer cohort was added in 2004, leading respondents from the initial HRS and WB cohorts to account for less than 50% of respondents aged 50-59. This percentage contiued to decline, and was below 10% in 2010, when the Mid Baby Boomer cohort was added.

Of individuals aged 50-59, the high-risk percentage between 1998 and 2012 ranged from 36.4% to 42.5%, with an average of 40.2%. This range was between 45.5% and 54.5%, with an average of 50.0% for individuals aged 60-69. Of individuals aged 70-79, this range was between 58.3% and 66.1%, with an average of 61.9%.

Comparison with Prior Studies

Braun, Kopecky and Koreshkova (2017), the study closest in time to mine, uses HRS data and estimates that the pecentage of Americans aged 55-65 who would be denied LTCI coverage due to poor health can reach 36%. However, it appears that this study does not utilizes HRS diseease follow-up questions or consider some important underwriting factors, such as BMI, difficulties with IADLs, and cognitive impairments. By addressing these issues, I find that 44.1% of the Americans aged 55-65 are potentially ineligible for LTCI coverage due to pre-existing conditions.[23] This estimate is 8.1-percentage-point (or 23%) higher than the estimate from Braun, Kopecky and Koreshkova (2017), because the estimation here more closely follows insurers' underwriting practices denying coverage to individuals with pre-existing conditions.

Risk Classification and LTCI Purchase

This paper uses underwriting guides and HRS data to find that 36% of individuals aged 50-59 are high-risk, potentially ineligible for LTCI coverage due to pre-existing conditions. If this risk classification effectively measures LTCI ineligiblity, one would expect that high-risk individuals are less likely to pass underwriting and therefore less likely to purchase LTCI coverage than their low-risk counterparts, if other factors, particularly the demand for LTCI coverage, can be assumed equal. HRS does not ask questions about LTCI purchase or coverage rejection, but whether respondents are covered by LTCI at the time of interview. Likewise, the HRS data do not observe respondents' risk status at the time right before purchasing LTCI, but at the time of interview. In spite of the data limitations, I explore the association between risk status and LTCI purchase. The analysis sample includes individuals aged 50-79 who were high-risk

[23] This percentage is the average of LTCI ineligibility rates from 1998 to 2012.

and not covered by LTCI in 1998. This analysis sample is chosen because these individuals might have similar demand for LTCI, given they had the same risk and LTCI coverage status in 1998. I examine these individuals' risk status and LTCI coverage in 2000. The underwriting practice predicts that holding other factors constant, being high-risk in 2000 would be associated with a lower chance of being covered by LTCI in 2000, because individuals in the analysis sample who became low-risk in 2000 would be more likely to pass underwriting and therefore more likely to purchase LTCI coverage between 1998 and 2000 than those remaining high-risk in 2000. Note that individuals may change from high- to low-risk because the underwriting guides reviewed suggest high-risk individuals be re-classified as low-risk if their ailments are cured.

The findings show that of respondents in the analysis sample who became low-risk in 2000, 6.1% were covered by LTCI in 2000. This percentage is 4.4% for their counterparts who remained high-risk in 2000.[24] Note that of those remaining high-risk in 2000, their LTCI coverage rate in 2000 might not be zero because some could have purchased LTCI if they became low-risk between the 1998 and 2000 interviews.[25] Overall, the findings appear to match the aforementioned prediction, suggesting the risk classification captures LTCI ineligiblity.

5. Influence of Pre-Existing Conditions on the Risk of Using a Nursing Home

This paper uses longitudinal HRS data to analyze the influence of pre-existing conditions on the lifetime likelihood of using a nursing home. I focus on individuals aged 50-59 because

[24] This difference (1.7 points) is statistically different from zero at 5% level of significance.

[25] An alternative explanation is that some could have purchased LTCI if they passed underwriting looser than the practices stated in the underwriting guides reviewed.

they are at the prime age of purchasing LTCI and planning for retirement; the findings can be disseminated to enhance their knowledge about the operation of LTCI policies and LTSS utilization risk, resulting in improved retirement planning.

Hurd, Michaud and Rohwedder (2014) and Castora-Binkley, Meng and Hyer (2014) suggest pre-existing conditions have two competing forces influencing the lifetime likelihood of using a nursing home: nursing home risk and mortaility risk. On the one hand, nursing home risk suggests that due to physicial and mental limitations, high-risk individuals have a higher likelihood of using a nursing home conditional on being alive. On the other hand, since high-risk individuals also face a higher mortality risk, this reduces their lifetime likelihood of using a nursing home.

The influence of pre-existing conditions is measured by the difference in the lifetime likelihood of using a nursing home between high- and low-risk individuals aged 50-59. This influence may diminish as individuals age because aging is associated with the onset of ailments, resulting in their becoming high-risk. The rate of becoming high-risk may be higher at older ages.

The influence of the two competing forces and aging is summarized in three testable hypotheses.

H1: Being high-risk is associated with a higher likelihood of using a nursing home when the competing force from mortality is not taken into account.

H2: This higher likelihood persists, yet is dampened, when the competing force from mortality is taken into account.

H3: This higher likelihood persists, yet diminishes, as individuals age.

5.1 Construction of Analytical File

This paper tests the three hypotheses by following low- and high-risk non-institutionalized individuals aged 50-59 in 1998 through the age of 96-105. Their risk status was re-classified every two years; for example, a low-risk individual in 1998 might become high-risk in 2000 or remain as low-risk. The information on nursing home use in the past two years is obtained from core and exit interviews, conducted for respondents who had died between waves with proxy informants, usually a widow, widower, or other family member knowledgeable about the deceased's health, family, and financial situation.

An analysis of nursing home use typically faces challenges arising from left and right censoring. Left censoring is defined as not observing nursing home stays occurring before 1991[26] for respondents from the HRS cohort or before 1996 for respondents from the WB cohort. Of individuals aged 50-59 in 1998, 65% came from the HRS cohort and 34% from the WB cohort. The data from 1992 to 1998 show that only 0.1% of low-risk individuals aged 50-59 in 1998 had ever used a nursing home between 1991 and 1998. This percentage is 0.8% for the high-risk counterparts. These two small percentages suggest very little left censoring, therefore is not addressed in this paper.

Right censoring refers to not following respondents until death so nursing home use occurring after a certain period is unobserved. Right censoring is caused by either attrition or an insufficient follow-up period. Attrition refers to respondents' dropping out of the sample or non-response even though they are alive and still considered in the sample. This analysis follows respondents from 1998 to 2012, which is not long enough to observe all respondents until death.

[26] The 1992 question asks about nursing home use in the past 12 months so nursing home use before 1991 is not observed. From 1993 on, the questions ask about nursing home use in the past two years.

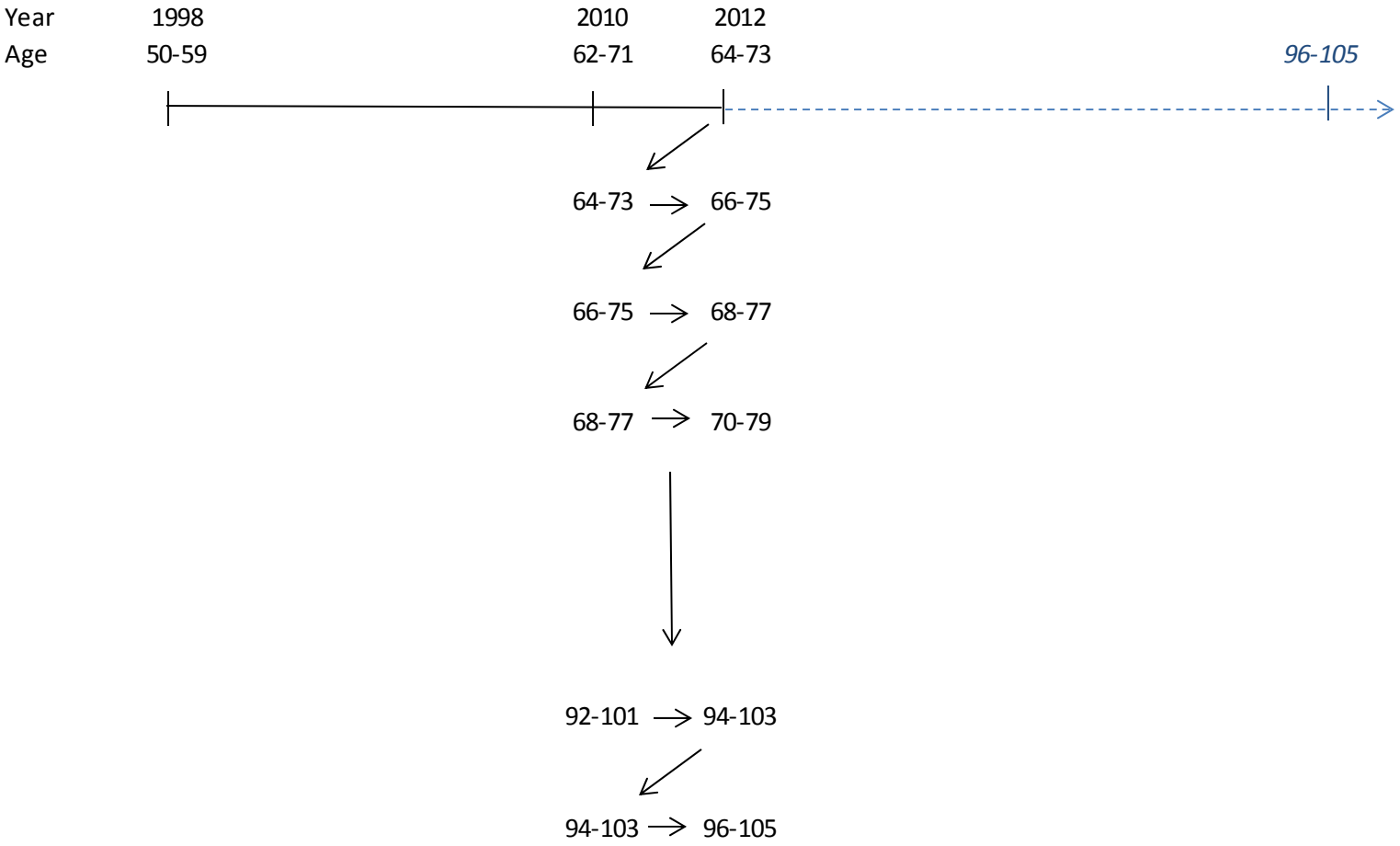
Individuals aged 50-59 in 1998 were aged 64-73 in 2012, with 70% alive and responsive, and 17% deceased, while 13% were attritors. This attrition rate is comparable to that calculated from Kapteyn, et al. (2006), which investigates the attrition of the HRS cohort from 1992 to 2002. Low-risk individuals aged 50-59 in 1998 were more likely to be alive and responsive in 2012 than their high-risk counterparts (75% versus 61%). This higher likelihood is driven by their lower mortality rate (9% versus 29%), even though their attrition rate is higher (16% versus 10%). This higher attrition rate is consistent with the findings of Banks, Muriel and Smith (2011), which investigates attrition and health of HRS respondents aged 55-64 from 2002 to 2006 and finds that attritors appear to be healthier than the full sample. Specifically, being diagnosed with arthritis, a common condition contributing to the high-risk classification, is associated with a lower attrition rate.

The issue of an insufficient follow-up period is similar to the challenge to create a cohort life table presenting the mortality experience of a particular birth cohort (e.g., born in 1945) from birth until no lives remain in this cohort. It is generally not feasible to create a cohort life table due to data unavailability. For example, a cohort life table representing the mortality experience of people born in 1945 would require projecting their deaths into the future since they are only 72 in 2017.

The period life table has been used as an alternative to the cohort life table. Instead of displaying the mortality experience of an actual birth cohort, the period life table presents what would happen to a hypothetical cohort if it experienced throughout its entire life the mortality conditions of a particular period in time.

As shown in Figure 2, this paper uses an approach, similar to the methods for building cohort and period life tables, to construct an analytical file examining the lifetime likelihood of

Figure 2: Flow Chart Illustrating the Construction of Analytical File



using a nursing home for individuals aged 50-59 in 1998. The solid horizontal line from the age of 50-59 to 64-73 represents the HRS data capturing the actual experience of this group. The dashed horizontal line beyond the age of 64-73 represents the ideal, yet infeasible cohort life table method following this group until the age of 96-105, when few members of this group are expected to be alive. The diagonal arrow pointing from age 64-73 in 2012 to the same age in 2010 represents the first step of the alternative, period life table method drawing a stratified random sample with replacement from active and responsive individuals aged 64-73 in 2010. This stratified random sample has the same distribution of risk status and nursing home use as that of the active and responsive individuals of age 64-73 in 2012. For example, of low-risk individuals aged 50-59 in 1998, 2,822 were alive and responded to the interview in 2012 at the age of 64-73. Of these,

- 1,440 were still low-risk without nursing home use in the past two years
- 8 were low-risk with nursing home use in the past two years
- 1,327 were high-risk without nursing home use in the past two years, and
- 47 were high-risk with nursing home use in the past two years

A random sample stratified by risk status and nursing home use is drawn from individuals aged 64-73 in 2010, in which each of the four strata has the same number of individuals as above. The horizontal arrow pointing from age 64-73 in 2010 to age 66-75 in 2012, repreesnt the second step of the method assuming the experience of individuals aged 64-73 in *2012* through the age of 66-75 would be identical to the experience of the stratified random sample through the age of 66-75. This assumption allows me to use the stratified random sample's experience at the age of 66-75 in 2012 to extend the experience of the low-risk individuals aged 50-59 in 1998 through the age of 66-75. The rest of the arrows in represent my repeating these two steps to

extend the experience of the low-risk individuals aged 50-59 in 1998 through the age of 96-105. The analytical file is completed when I follow the same method to extend the experience of the high-risk counterparts.

Active and responsive individuals in 2010 fall into one of three statuses in 2012: (1) alive and responsive; (2) deceased; (3) alive, yet non-responsive. When drawing a stratified random sample from individuals in 2010, I adopt an unbalanced panel approach in which all alive and responsive individuals in 2010 are candidates to be selected into the stratified random sample, including those becoming non-responsive in 2012. This approach appears to be more suitable than the balanced panel approach excluding those alive, yet non-responsive in 2012 from sampling consideration because, as Kapteyn, et al. (2006) suggests, the balanced panel approach may be contaminated by a larger selection on observables than the unbalanced panel approach. Roughly 4% of the active and responsive indivdiuals in 2010 were alive, yet non-responsive in 2012.

Nevertheless, I also report findings from the balanced panel approach because Hurd, Michaud and Rohwedder (2014) appears to use this approach in their estimating the lifetime risk of nusing home use; the status of being alive, yet non-responsive is not mentioned in their analysis.

This construction adopts nursing home use experience in 2010 and 2012 to extend the experience of individuals aged 50-59 in 1998 through the age of 96-105. To project this group's experience, the data from 2010 and 2012 are more suitable than prior years' data because the latter may result in underestimation; Table 7 shows that conditional on age, the likelihood of using a nursing home in the past two years increases over time. This lack of stationarity is in

Table 7: Percentage of Using a Nursing Home in the Past Two Years

Age Group	Wave							
	1998	2000	2002	2004	2006	2008	2010	2012
50-59	0.24	0.24	0.61	0.45	0.94	1.17	1.54	2.23
60-69	0.66	0.92	1.31	1.73	2.38	3.16	4.13	5.01
70-79	1.87	2.04	3.87	4.07	6.16	6.55	9.75	8.58
80+	5.28	5.8	8.92	7.93	13.27	8.66	16.51	16.23

1. Information from both core and exit interviews is included.

2. In each wave, the percentages are weighed by person-level weights applying to those living in the community; weights are 0 for those living in a nursing home at the time of interview.

contrast to the findings of Hurd, Michaud and Rohwedder (2014) showing some evidence of stationarity in the likelihood of residing in a nursing home at the time of interview.

5.2 Analytical Method

I present the analytical method for estimating the influence of pre-existing conditions on the lifetime likelihood of using a nursing home. Since very few people aged 50-59 have used a nursing home, a natural outcome of interest is time to first nursing home use, which leads to the use of survival analysis in estimation.

Three models are used in estimation to test robustness of the results. The first is a discrete-time proportional hazards model using the complementary log-log regression. The discrete-time method is used because while time to first nursing home use may happen in a continuous range of time, it is interval-censored. This censoring arises because time to first nursing home use is only observed at discrete moments (i.e., every two years when the interview is conducted). For example, neither nursing home use occuring 2 or 14 months after the 2000 interview was observed until the 2002 interview.

The assumption of proportional hazards is commonly-used to parameterize the effect of a covariate (i.e., pre-existing conditions). This assumption yields a constant hazard ratio between individuals who are high-risk at the age of 50-59 and their low-risk counterparts. That is, the hazard faced by the high-risk group is multiplicatively proportional to the baseline hazard. This assumption seems to be unsuitable because the third hypothesis suggests the influence of pre-existing conditions persists, yet diminishes over time. Still, it is appropriate to use a model with the assumption of proportional hazards to test a time-dependent effect by reporting a series of hazard ratios for increasingly longer follow-up periods (Dekker, et al. 2008; Hernan 2010; Bellera, et al. 2010). If the effect declines over time, the hazard ratio from a longer follow-up period (e.g., at the age of 90-99 when the follow-up period is 40 years) would be smaller than that from a shorter follow-up period (e.g., at the age of 70-79 when the follow-up period is 20 years). This pattern arises because the hazard ratio is estimated by considering each time t when a failure event occurs. When estimating the hazard ratio over a follow-up period, the same weights are assigned to the very early hazard ratio affecting almost all individuals and to the very late hazard rato affecting only a small number of individuals still at risk. The hazard ratio is therefore averaged over the event times in the follow-up period. Compared with the hazard ratio from a shorter follow-up period (e.g., 20 years), the hazard ratio from a longer follow-up period (e.g., 40 years) utilizes the event time information during the shorter, as well as the later period. If the effect is smaller during the later period than the shorter, this suggests the hazard ratio averaged over the event times in the longer period would be smaller than that averaged over the event times in the shorter period.

The second is the Cox proportional hazards model, which analyzes the interval-censored data by using a continuous-time method. The estimated hazard ratios of these two models are

expected to be greater than 1, suggesting pre-existing conditions elevates the hazard of using a nursing home.

In both the complementary log-log and Cox models, the failure event is nursing home use, and death and attrition are considered as censored, defined as having incomplete information on time to nursing home use. This consideration assumes death and attrition occur independently of nursing home use. These two models are suitable for testing the first hypothesis regarding the positive association between being high-risk and the likelihood of using a nursing home when mortality risk is not considered. However, to test the second hypothesis regarding the positive, yet dampened association when mortality risk is considered, I use the third model, the competing-risks model, and no longer assume death and nursing home use are independent. This model includes the competing force from mortality by treating nursing home use as the event of interest and death as a competing event. The competing event, death, prevents the occurrence of the event of interest, nursing home use. This model observes the minimum of two potential failure times: (1) time to the event of interest; (2) time to the competing event. Therefore, the competing-risks model estimates the likelihood of nursing home use attributable to both the nursing home risk and mortality risk.

The complementary log-log and Cox models focus on hazard and survivor functions. In contrast, the competing-risks model focuses on the subhazard function and cumulative incidence function. The hazard function, also known as the conditional rate of nursing home use, is the probability that nursing home use occurs in a given interval, conditional on the subject's not having used a nursing home by the beginning of the interval. The survivor function at time t is the probability of first nursing home use occuring after time t. The subhazard function is the limiting probablity of first nursing home use at time t given either no nursing home use before t

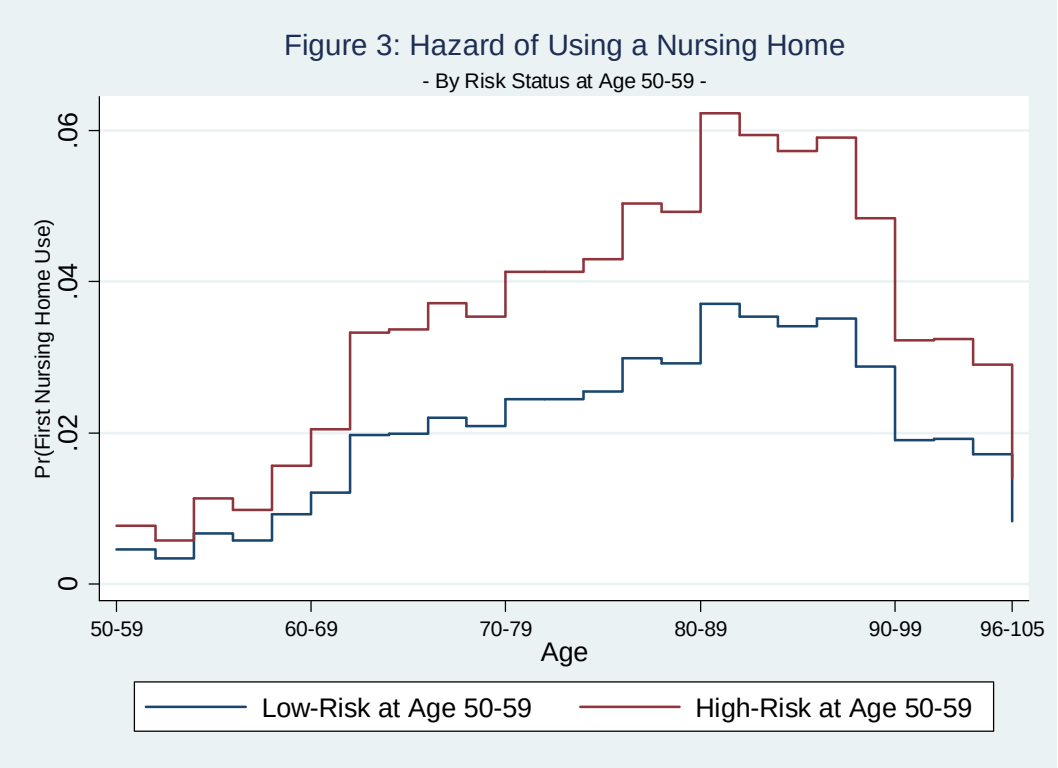
or having died before t. The subhazard function can be informally interpreted as the limiting probablity of first nursing home use, while keeping deceased subjects "at risk of nursing home use" so they can be suitably counted as not having any chance of failing. The cumulative incidence function (CIF) at time t is the probablity of using a nursing home up to time t.

The third hypothesis states the positive association between being high-risk at the age of 50-59 and the likelihood of using a nursing home persists, yet diminishes, as indivdiuals age. This hypothesis is tested by varying the length of the follow-up period. When the third hypothesis holds, the estimated hazard ratio from a shorter follow-up period would be larger than that from a longer follow-up period. This expectation applies to all three models.

5.3 Estimates of the Influence of Pre-Existing Conditions

Figure 3 and Table 8 present the findings of pre-existing conditions' influence on the likelihood of using a nursing home. The analytical file is constructed by using an unbalanced panel approach when drawing stratified random samples to extend the follow-up period beyond 14 years. Figure 3 shows the hazard of using a nursing home from the age of 50-59 to 96-105, with the blue (red) line displaying the hazard of individuals who are low-risk (high-risk) at the age of 50-59.

Of those who are low-risk at the age of 50-59, their hazard increases from slightly greater than 0 at the age of 50-59, to nearly 0.04 at the age of 80-89, and declines to 0.02 at the age of 90-99. This probability indicates of 1,000 individuals who are low-risk at the age of 50-59 and alive at the age of 88-97, and have not used a nursing home, 20 would enter a nursing home during the 2-year interval between the age of 88-97 and 90-99. Of the high-risk counterparts, their hazard follows a similar trend, rising from nearly 0.01 at the age of 50-59, to over 0.06 at the age of 80-89, and declines to roughly 0.03 at the age of 90-99. This rising, yet then declining



trend can be explained by two competing forces: nursing home risk and mortality risk. Before the age of 80-89, the hazard rises steadily because the nursing home risk outweighs the mortality risk; individuals are getting frailer, but are still alive. After the age of 80-89, the hazard declines because the mortality risk outweighs the nursing home risk; the frailest have died, leaving those alive with a lower likelihood of using a nursing home.

The gap between the red and blue lines measures the elevated hazard due to pre-existing conditions. This gap gradually increases from the age of 50-59 to 88-97, and shrinks after 88-97. Likewise, this increasing, yet then shrinking gap can be explained by the nursing home risk and mortality risk. Pre-existing conditions raise both nursing home and mortality risks, and delay the time when the rising nursing home risk is outweighed by the rising mortality risk until the age of 88-97. At that age, the gap reverses from growing to shrinking.

Table 8: Association Between Risk Status at Age 50-59 and Nursing Home Use
(Unbalanced Panel is Used When Drawing a Stratified Random Sample to Extend the Follow-up Period)

Length of Follow-Up (Year)	Age	Alive (%)		Discrete Time	Continuous Time		Cumulative Likelihood of Using Nursing Home (%)		
		[1] Low-Risk at Age 50-59	[2] High-Risk at Age 50-59	[3] Complementary Log-Log Hazard Ratio	[4] Cox Hazard Ratio	[5] Subhazard Ratio	[6] Low-Risk at Age 50-59	[7] High-Risk at Age 50-59	[8] Difference
0	50-59	100	100	N/A	N/A	N/A	0.2	1.2	1.00
10	60-69	81	72	5.24	5.20	4.92	2.0	9.5	7.52
20	70-79	59	46	2.65	2.63	2.29	10.3	22.1	11.74
30	80-89	35	25	2.02	2.01	1.66	20.7	32.0	11.28
40	90-99	16	10	1.80	1.78	1.41	30.5	40.1	9.61
46	96-105	7	3	1.70	1.69	1.35	32.2	40.9	8.69

1. The analysis focuses on non-institutionalized individuals aged 50-59 in 1998. Each row varies in the length of follow-up period. For example, the third row reports findings at 20 years of follow-up, when individuals are 70-79 years old. "Alive" refers to responsents who were alive and responded to the interview.
2. Hazard ratio refers to the hazard ratio between two types of individuals: (1) high-risk at age 50-59; (2) low-risk at age 50-59. Complementary log-log hazard ratio is estimated from the complementary log-log proportional hazards model. Cox hazard ratio is estimated from the Cox proportional hazards model. The subhazard ratio and cumulative likelihood of using a nursing home are estimated from the competing-risks model developed in Fine and Gray (1999). These three types of estimation use an analytical file extending the experience of individuals aged 50-59 in 1998 through the age of 96-105. As discussed in Section 5.1, this extension involves stratified random sampling with replacement beyond 14 years of follow-up. Unbalanced panel is used when drawing the sample. To avoid sampling anomaly due to chance, 1,001 samples were drawn. For each of the follow-up periods greater than 14 years, I report findings from the sample generating the median estimate in the competing-risks model. Therefore, from the third row on, results in the same row are from the same sample. Sampling is not involved in the first two rows because the HRS data capture the actual experience of these individuals. No estimation is performed in the first row, whose cumulative likelihoods of using a nursing home are obtained from the HRS data from 1992 to 1998.
3. All estimates of the hazard or subhazard ratio are different from 1 at the 1% level of significance.

Overall, the gap persists through the age of 96-105, suggesting pre-existing conditions have a lasting effect on increasing the likelihood of using a nursing home.

In Figure 3, the hazard is estimated by using the complementary log-log model with a follow-up of 46 years. This length of follow-up is the same as that of the last row of Table 8, which shows at the age of 96-105, 7% of the individuals who are low-risk at the age of 50-59 are still alive and responsive to the interview. This percentage is 3% for the high-risk counterparts. Columns [3] and [4] report estimates of the hazard ratio between individuals who are high-risk at the age of 50-59 and their low-risk counterparts, with column [3] using the discrete-time complementary log-log model and column [4] using the continuous-time Cox model. Under the proportional hazards assumption, the last row of column [3] reports an estimated hazard ratio of 1.7, suggesting the presence of pre-existing conditions elevates the hazard by roughly 70% when the follow-up is 46 years. This elevation is consistent with the prediction of the first hypothesis. This estimate is very similar to its continuous-time counterpart in column [4], 1.69, suggesting the influence of pre-existing conditions is robust with respect to the time to nursing home use being modeled as discrete-or continuous-time. This robustness warrants using the continuous-time competing-risks model to test the second hypothesis.

The results from the competing-risks model are reported in columns [5]-[8]. Column [5] reports estimates of the subhazard ratio, interpreted as the relative risk of using a nursing home between individuals who are high-risk at the age of 50-59 and their low-risk counterparts when the competing force from mortality risk is considered. The last row of this column reports an estimated subhazard ratio of 1.35, suggesting with a 46-year follow-up, pre-existing conditions elevates the hazard by roughly 35% when mortality risk is considered. This estimate is smaller than its counterparts in columns [3] and [4], in which mortality risk is not modeled. This smaller

estimate, consistent with the prediction of the second hypothesis, provides evidence for the influence of mortality risk, which partially offsets pre-existing conditions' elevating the risk of using a nursing home.

Columns [6]-[8] report estimates of the cumulative likelihood of using a nursing home, the absolute risk of using a nursing home faced by low- and high-risk individuals aged 50-59. The last row of these columns reports an estimated cumulative likelihood of 32.2% for low-risk individuals aged 50-59. This likelihood indicates of 1,000 individuals who are low-risk at the age of 50-59, 322 would have entered a nursing home by the age of 96-105. This cumulative likelihood is 40.9% for the high-risk counterparts. The risk differential in the cumulative likelihood is 8.69 percentage points, suggesting pre-existing conditions increases the lifetime likelihood of using a nursing home by nearly 9 percentage points.

Figure 3 and the last row of Table 8 use the same analytical file, constructed by drawing stratified random samples to extend the follow-up from 14 to 46 years. To avoid sampling anomaly due to chance, 1,001 samples are drawn. I report findings from the sample generating the median estimate in the competing-risks model. This sample is used for Figure 3 and all columns of the last row of Table 8.

The third hypothesis states the influence of pre-existing conditions on nursing home use persists, yet diminishes over time. This hypothesis is tested by analyzing the extent to which the hazard ratio responds to change in the length of the follow-up. This analysis is shown in the six rows in Table 8, with the length of the follow-up increasing by 10 years from one row to the next, until reaching 46 years in the last row. The follow-up is not extended to 50 years because the number of alive and responsive individuals is limited at 46 years of follow-up.

Column [3] shows the estimated hazard ratios, from the complementary log-log model, steadily decline from 5.24 at 10 years of follow-up, to 1.7 at 46 years of follow-up. This steady decline also appears in the estimated hazard ratios from the Cox model in column [4], and their subhazard ratio counterparts from the competing-risks model in column [5]. The results from these three columns suggest while pre-existing conditions' influence diminishes over time, these conditions have a lifetime effect on elevating the likelihood of using a nursing home. This lifetime effect is also evidenced in columns [6]-[8], which show the cumulative likelihood of using a nursing home of low-risk individuals aged 50-59 steadily increases from 0.2% at the age of 50-59, to 32.2% at the age of 96-105. For high-risk individuals aged 50-59, this increase is from 1.2% at the age of 50-59 to 40.9% at the age of 96-105. The risk differential in the cumulative likelihood, measuring pre-existing conditions' effect on elevating the risk of using a nursing home, displays an inverted U-shaped curve, increases from 1 percentage point at the age of 50-59, reaches 11.74 percentage points at the age of 70-79, stays steady through the age of 80-89, and declines to 8.69 percentage points at the age of 96-105.

Gender-Specific Influence of Pre-Existing Conditions

As shown in Section 4.2, a higher percentage of the females aged 50-59 have one or more pre-existing conditions than their male counterparts (40% versus 32%). In Figures 4-5 and Table 9, I show the association between gender and pre-existing conditions' influence on the likelihood of using a nursing home.

Figure 4 (5) displays the nursing home use hazard of male (female) individuals from the age of 50-59 to 96-105. For both genders, the trend of the red- (blue-) lined hazard faced by high- (low-) risk individuals aged 50-59 is similar to the overall trend displayed in Figure 3; the

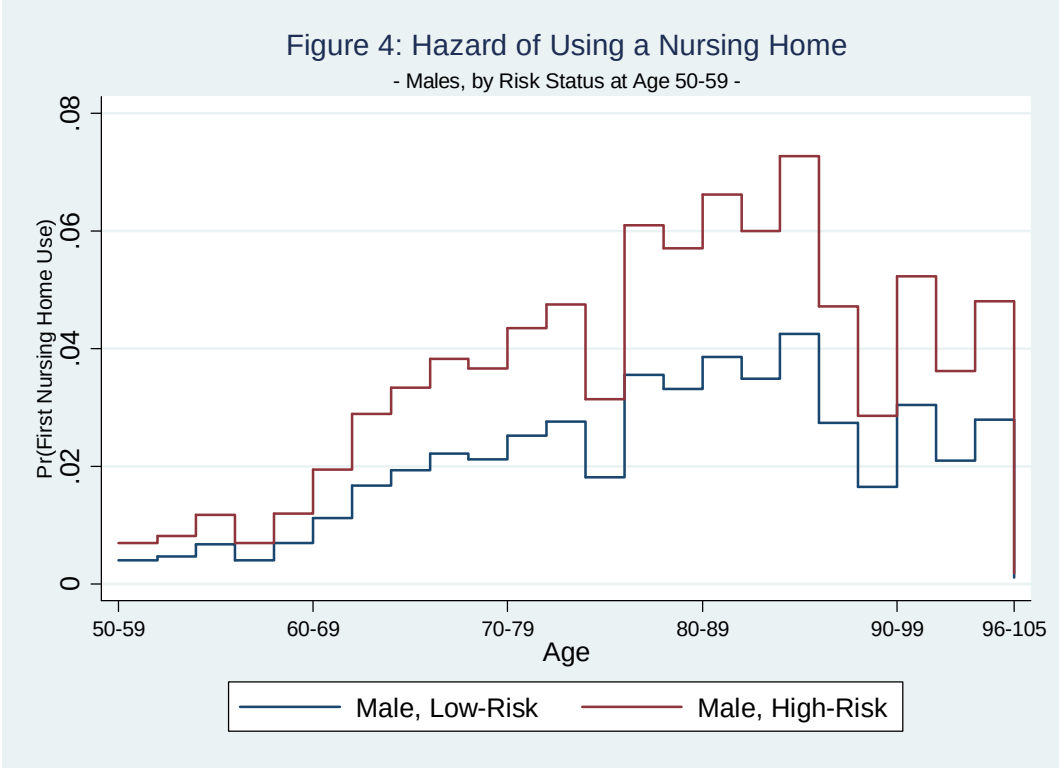


Figure 4: Hazard of Using a Nursing Home
- Males, by Risk Status at Age 50-59 -
Pr(First Nursing Home Use)
0
.02
.04
.06
.08
50-59
60-69
70-79
80-89
90-99
96-105
Age
Male, Low-Risk
Male, High-Risk

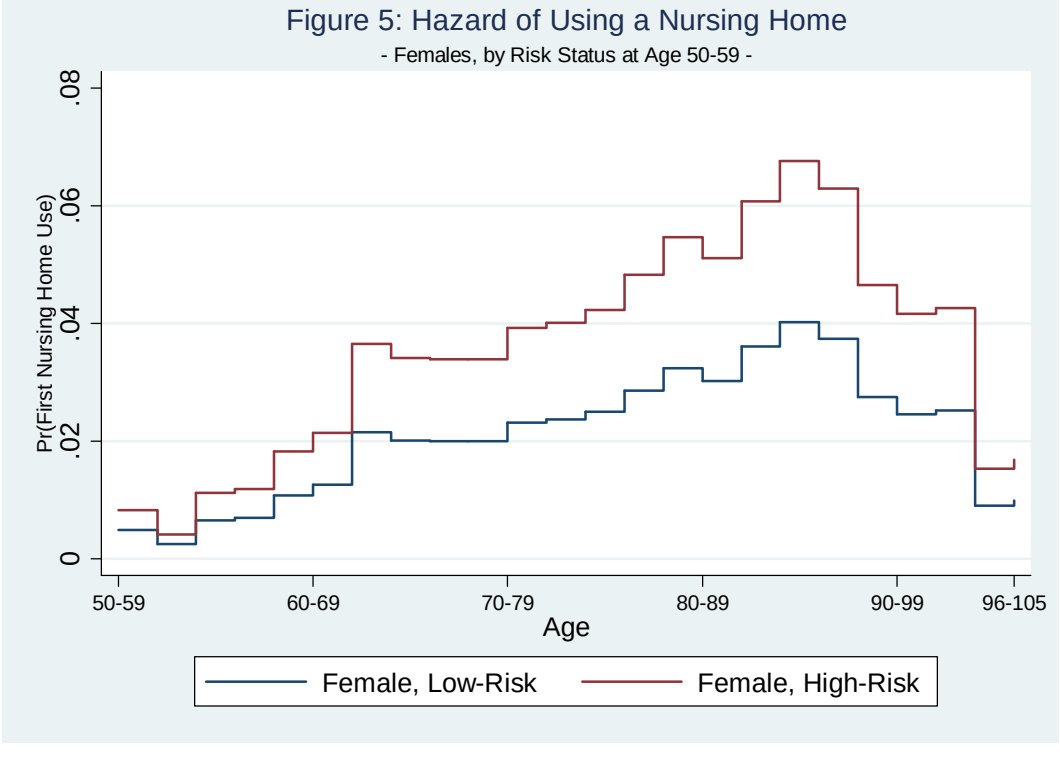


Figure 5: Hazard of Using a Nursing Home
- Females, by Risk Status at Age 50-59 -
Pr(First Nursing Home Use)
0
.02
.04
.06
.08
50-59
60-69
70-79
80-89
90-99
96-105
Age
Female, Low-Risk
Female, High-Risk

Table 9: Gender-Specific Association Between Risk Status at Age 50-59 and Nursing Home Use (Unbalanced Panel is Used When Drawing a Stratified Random Sample to Extend the Follow-up)

Length of Follow-Up (Year)	Age	Alive (%)		[3]	Cumulative Likelihood of Using Nursing Home (%)		
		[1] Low-Risk at Age 50-59	[2] High-Risk at Age 50-59	Subhazard Ratio	[4] Low-Risk at Age 50-59	[5] High-Risk at Age 50-59	[6] Difference
Panel A: Males							
0	50-59	100	100	N/A	0.1	1.2	1.10
10	60-69	80	65	5.62	1.7	9.3	7.60
20	70-79	55	38	2.18	10.6	21.8	11.20
30	80-89	30	20	1.54	20.6	30.0	9.40
40	90-99	14	7	1.31	27.6	34.5	6.90
46	96-105	7	3	1.26	30.6	36.9	6.30
Panel B: Females							
0	50-59	100	100	N/A	0.20	1.20	1.00
10	60-69	82	76	4.47	2.3	9.7	7.43
20	70-79	62	53	2.31	10.9	23.4	12.50
30	80-89	41	30	1.71	21.5	33.8	12.36
40	90-99	15	13	1.45	31.7	42.5	10.80
46	96-105	6	4	1.39	33.7	43.6	9.90

1. This table differs from Table 8 in its panel A including the males only, while panel B includes the females only. To conserve space, hazard ratio estimates from the complementary log-log and Cox models are omitted; these estimates lead to the same conclusion as the subhazard ratio estimates from the competing-risks model. The rest of the table is the same as that in Table 8. See the notes in Table 8 for the details.

hazard rises from the age of 50-59, to the age of 86-95, and declines afterwards. This trend also appears in the gap between the red and blue lines, measuring the elevated hazard due to pre-existing conditions.

When comparing genders, conditional on risk status at the age of 50-59, there is no clear pattern showing one gender's hazard is higher than the other's throughout the follow-up. For

example, of high-risk individuals, the females have a higher hazard than their male counterparts by the age of 64-73, while the males have a higher hazard between 66-75 and 74-83. Table 9 reports the gender-specific association between risk status at the age of 50-59 and the likelihood of using a nursing home. The first two columns show that for both risk types, the females live longer than their male counterparts. For example, of high-risk individuals aged 50-59, 30% of the females are still alive at the age of 80-89, compared to 20% for their male counterparts. The third column reports the subhazard ratio estimates from the competing-risks model. For both genders, the estimates decline as the length of the follow-up increases. Since the estimates are still above 1, this suggests pre-existing conditions have a diminishing, yet lasting influence on the likelihood of using a nursing home. Conditional on the length of the follow-up, the females have a slightly larger subhazard ratio estimate than their male counterparts. This suggests pre-existing conditions have a slightly larger influence on the females than males. This slightly larger influence is also shown in the last three columns, which report estimates of the cumulative likelihood of using a nursing home. At the age of 96-105, the cumulative likelihood is 30.6% for male individuals who are low-risk at the age of 50-59. This likelihood is 36.9% for their high-risk counterparts. The risk differential in the cumulative likelihood is 6.3 percentage points for the males. Of the female counterparts, the cumulative likelihoods are 33.7% and 43.6%, respectively, for the low- and high-risk. The risk differential is 9.9 percentage points for the females.

Comparison with Prior Studies

To the best of my knowledge, this is the first study analyzing the association between pre-existing conditions and the likelihood of using a nursing home. The findings suggest of individuals aged 50-59, pre-existing conditions elevate their lifetime likelihood of using a nursing home from 32.2% to 40.9%. The overall likelihood of using a nursing home, weighed by the proportion of high- and low-risk individuals at the age of 50-59, is 35.4%. This likelihood is smaller than the findings of Hurd, Michaud and Rohwedder (2014), which indicates individuals in their 50s have an over 50% chance of entering a nursing home before they die. This smaller likelihood may be explained by this paper's using an unbalanced panel approach to extend the follow-up period, while Hurd, Michaud and Rohwedder (2014) uses a balanced panel approach for this extension. Their use of a balanced panel approach may help answer the question raised in Cutler (2014) about their higher estimate. As discussed in Section 5.1, when drawing a stratified random sample from individuals in 2010 to extend the follow-up period, I adopt an unbalanced panel approach in which all alive and responsive individuals in 2010 are candidates to be selected into the stratified random sample, including those becoming non-responsive in 2012. In contrast, Hurd, Michaud and Rohwedder (2014) appears to use a balanced panel approach when estimating the lifetime likelihood of using a nursing home because the status of being alive, yet non-responsive is not included in their variable on the next wave's status.[27]

Table 10 repeats the analysis in Table 8, but extends the follow-up period by using a balanced panel approach, exlcuding individuals becoming non-responsive in 2012 from being selected into a stratiifed random sample. Compared with Table 8, a higher percentage of

[27] This variable has four values: (1) alive and living in the community; (2) alive and living in a nursing home; (3) died in the community; (4) died in a nursing home.

Table 10: Association Between Risk Status at Age 50-59 and Nursing Home Use
(Balanced Panel is Used When Drawing a Stratified Random Sample to Extend the Follow-up Period)

Length of Follow-Up (Year)	Age	Alive (%)		Discrete Time	Continuous Time		Cumulative Likelihood of Using Nursing Home (%)		
		[1] Low-Risk at Age 50-59	[2] High-Risk at Age 50-59	[3] Complementary Log-Log Hazard Ratio	[4] Cox Hazard Ratio	[5] Subhazard Ratio	[6] Low-Risk at Age 50-59	[7] High-Risk at Age 50-59	[8] Difference
0	50-59	100	100	N/A	N/A	N/A	0.2	1.2	1.00
10	60-69	81	72	5.24	5.20	4.92	2.0	9.5	7.52
20	70-79	66	52	2.59	2.57	2.22	11.0	22.8	11.84
30	80-89	51	35	1.94	1.92	1.56	23.8	34.5	10.69
40	90-99	27	17	1.71	1.70	1.28	39.5	47.4	7.93
46	96-105	12	7	1.62	1.61	1.21	44.1	50.5	6.46

1. This table differs from Table 8 in its using a balanced panel when drawing a stratified random sample to extend the follow-up period. The rest of the table is the same as that in Table 8. See the notes in Table 8 for the details.

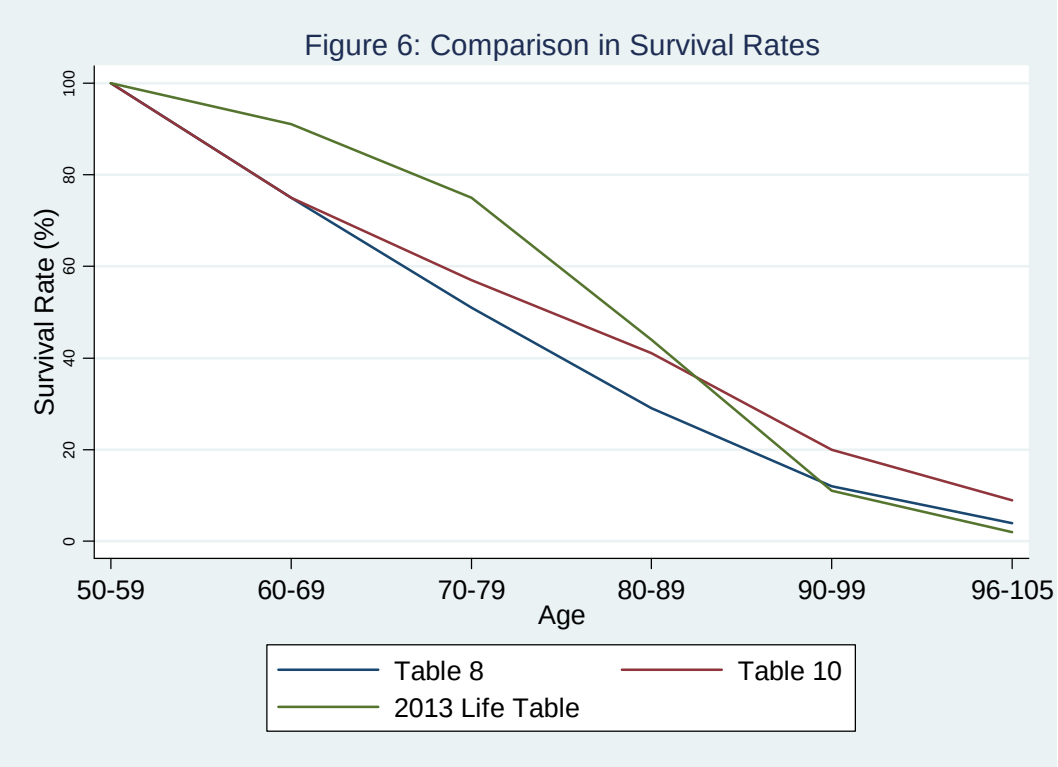
indivdiuals are alive at later stages of life. The estimates of hazard and subhazard ratios are slightly smaller than those in Table 8, but qualitatively similar. The estimated cumulative likelihood of using a nursing home at the age of 96-105 is 44.1% for indivdiuals who are low-risk at the age of 50-59. This likelihood is 50.5% for the high-risk counterparts. The overall likelihood of using a nursing home is 46.4%.

The results from Tables 8 and 10 indicate the change from the unbalanced to balanced approach increases individuals aged 50-59's lifetime likelihood of using a nursing home from 35.4% to 46.4%. This 11-point increase may be attributable to the reduction in the percentage of individuals censored due to attrition, from roughly 30% in Table 8 to 10% in Table 10. This reduction is explained by the unbalanced panel approach's allowing for attrition both in the first 14 years of follow-up using the actual experience, and the latter 32 years of follow-up using stratified random sampling. In contrast, the balanced panel approach allows for attribution only in the first 14 years of follow-up.

While the balanced panel approach reduces the attrition rate in the analytical file, it may create a larger problem of selection on observables because as discussed in Section 5.1, attritors appear to be healthier than the full HRS sample. Since the balanced panel approach excludes attritors in 2012 from sampling consideration, this suggests individuals in its analytical file may be sicker than those in the analytical file obtained from the unbalanced panel approach, therefore driving up the cumulative likelihood of using a nursing home.

In addition, Figure 6 compares the survival rate in Tables 8 and 10 to that derived from the 2013 United States life tables, the most recent mortality experience of Americans. The green line displays the survival rate if individuals aged 50-59 in 1998 experienced throughout the follow-up period the mortality conditions in 2013. This rate is used as a proxy for the true

survival rate of individuals aged 50-59 in 1998. The blue (red) line shows the survival rate, defined as the percentage of being alive and responsive, in Table 8 (10). The survival rate beyond the age of 82-91 in Table 10 is higher than that derived from the life tables, suggesting the balanced panel approach might have shifted the age distribution to older ages, consequently driving up the cumulative likelihood of using a nursing home.



6. Conclusion

The increasing demand for and rising prices of LTSS make preparing for the financial risk due to utilizing LTSS an integral part of retirement planning. LTCI is an option to finance LTSS expenditures, and its role in retirement planning may grow as Americans are increasingly more responsible for their own retirement security. However, not all individuals are eligible to purchase LTCI coverage because to deter adverse selection, insurers deny coverage to individuals with pre-existing conditions. This paper uses underwriting guides from seven

insurers and the HRS data, notably its disease follow-up questions, to find that 36% of individuals in their 50s have 1 or more pre-existing conditions which may prevent them from obtaining LTCI coverage. This paper analyzes the extent to which pre-existing conditions influence the lifetime likelihood of using a nursing home. I develop an analytical file to follow individuals in their 50s through the age of 96-105, and perform survival analysis to show pre-existing conditions are associated with a 9-percentage-point increase in the lifetime likelihood of using a nursing home. The results suggest this increase persists through time. The findings can be disseminated to enhance consumers' knowledge about the possibility of LTCI coverage rejection and the likielihood of using a nursing home. This enhancement may improve retirement planning.

This paper is a work-in-progress, and four steps will be taken to refine the analysis. First, more research will be conducted to investigate how censoring due to attrition affects the estimates of cumulative likelihood of using a nursing home. Second, a discrete-time competing-risks model will be used to estimate the influence of pre-existing conditions on nursing home use. Third, the analysis will be expanded to include the intensity of nursing home use. That is, conditional on nusring home use, I will examine whether pre-existing conditions are associated with more and longer nursing home stays. Finally, the analysis will be expanded to include home care, a type of LTSS likely to be more cost-effective than nursing home.

References

American Association for Long-Term Care Insurance. *Long-Term Care Insurance Facts - Statistics.* 2017. http://www.aaltci.org/long-term-care-insurance/learning-center/fast-facts.php (accessed September 12, 2017).

—. *Long-Term Care Insurance Health Qualifications. Are You Even Insurable?* 2017. http://www.aaltci.org/long-term-care-insurance/learning-center/are-you-even-insurable.php (accessed September 12, 2017).

—. *Six Long-Term Care Insurance Companies Report Sales Growth.* 2016. http://www.aaltci.org/news/long-term-care-insurance-association-news/six-long-term-care-insurance-companies-report-sales-growth (accessed September 12, 2017).

Ameriks, John, Joseph Briggs, Andrew Caplin, Matthew D. Shapiro, and Christopher Tonetti. "Late-in-Life Risks and the Under-Insurance Puzzle." *NBER Working Paper 22726*, 2016.

Arias, Elizabeth, Melonie Heron, and Jiaquan Xu. "United States Life Tables, 2013." *National Vital Statistics Reports*, April 11, 2017.

Banks, James, Alastair Muriel, and James P. Smith. "Attrition and Health in Aging Studies: Evidence from ELSA and HRS." *Longitudinal and Life Course Studies* 2, no. 2 (2011): 101-126.

Barbour, Kamil E., Charles G. Helmick, Michael Boring, and Teresa J. Brady. "Vital Signs: Prevalence of Doctor-Diagnosed Arthritis and Arthritis-Attributable Activity Limitation

— United States, 2013–2015." *Morbidity and Mortality Weekly Report*, March 10, 2017: 246-53.

Bellera, Carine A., Gaetan MacGrogan, Marc Debled, Christine Tunon de Lara, Veronique Brouste, and Simone Mathoulin-Pelissier. "Variables with Time-Varying Effects and the Cox Model: Some Statistical Concepts Illustrated with a Prognostic Factor Study in Breast Cancer." *BMC Medical Research Methodology*, 2010: 10:20.

Braun, R. Anton, Karen A. Kopecky, and Tatyana Koreshkova. "Old, Frail, and Uninsured: Accounting for Puzzles in the U.S. Long-Term Care Insurance Market." *Federal Reserve bank of Minneapolis Working Paper*, 2017.

Brown, Jeffrey R., and Amy Finkelstein. "Insuring Long-Term Care in the United States." *Journal of Economic Perspectives* 25, no. 4 (2011): 119-142.

Brown, Jeffrey R., and Amy Finkelstein. "The Interaction of Public and Private Insurance: Medicaid and the Long-Term Care Insurance Market." *American Economic Review* 98, no. 3 (2008): 1083-1102.

Brown, Jeffrey R., and Amy Finkelstein. "Why is the Market for Long-Term Care Insurance So Small?" *Journal of Public Economics* 91, no. 10 (2007): 1967-91.

Brown, Jeffrey R., Norma B. Coe, and Amy Finkelstein. "Medicaid Crowd-Out of Private Long-Term Care Insurance Demand: Evidence from the Health and Retirement Study." *Tax Policy and the Economy* 21 (2007): 1-34.

Castora-Binkley, Melissa, Hongdao Meng, and Kathryn Hyer. "Predictors of Long-Term Nursing Home Placement Under Competing Risk: Evidence from the Health and Retirement Study." *Journal of the American Geriatrics Society* 62, no. 5 (2014): 913-8.

Cleves, Mario, William W. Gould, and Yulia V. Marchenko. *An Introduction to Survival Analysis Using Stata, Revised Third Edition.* College Station, TX: Stata Press, 2016.

Coe, Norma B, Meghan M Skira, and Courtney Harold Van Houtven. "Long-Term Care Insurance: Does Experience Matter?" *Journal of Health Economics* 40 (2015): 122-31.

Congressional Budget Office. "Rising Demand for Long-Term Services and Supports for Elderly People." 2013.

Cutler, David M. "Comment on "The Lifetime Risk of Nursing Home Use"." In *Discoveries in the Economics of Aging,* edited by David A. Wise, 110-13. University of Chicago Press, 2014.

Davidoff, Thomas. "Home Equity Commitment and Long-Term Care Insurance Demand." *Journal of Public Economics* 94, no. 1-2 (2010): 44-49.

Dekker, Friedo W., Renee de Mustert, Paul C. van Dijk, Carmine Zoccali, and Kitty J. Jager. "Survival Analysis: Time-Dependent Effects and Time-Varying Risk Factors." *Kidney International* 74, no. 8 (2008): 994-997.

Fine, Jason P., and Robert J. Gray. "A Proportional Hazards Model for the Subdistribution of a Competing Risk." *Journal of the American Statistical Association* 94, no. 446 (1999): 496-509.

Finkelstine, Amy, and Kathleen McGarry. "Multiple Dimensions of Private Information: Evidence from the Long-Term Care Insurance Market." *American Economic Review* 96, no. 4 (2006): 938-58.

Fisher, Gwenith G., Halimah Hassan, Jessica D. Faul, and Willard L. Rodgers. *Health and Retirement Study Imputation of Cognitive Functioning Measures: 1992-2012 Data Description (Final Release Version).* Ann Arbor, MI: Survey Research Center University of Michigan, 2015.

Freedman, Vicki,A., Hakan Aykan, and Linda, G Martin. "Aggregate Changes in Severe Cognitive Impairment Among Older Americans: 1993 and 1998." *Journal of Gerontology* 56B, no. 2 (2001): S100-S111.

Friedberg, Leora, Wenliang Hou, Wei Sun, Anthony Webb, and Zhenyu Li. "New Evidence on the Risk of Requiring Long-Term Care." *Center for Retirement Research at Boston College Working Paper*, 2014.

Genworth Financial. "Genworth 2009 Cost of Care Survey: Home Care Providers, Adult Day Health Care Facilities, Assisted Living Facilities and Nursing Homes." 2009.

Genworth Financial. "Geworth 2016 Cost of Care Survey: Summary." 2016.

Hendren, Nathaniel. "Private Information and Insurance Rejections." *Econometrica* 81, no. 5 (2013): 1713-62.

Hernan, Miguel A. "The Hazards of Hazard Ratios." *Epidemiology* 21, no. 1 (2010): 13-15.

Herzog, A. Regula, and Robert B. Wallace. "Measures of Cognitive Functioning in the AHEAD Study." *Journal of Gerontology* 52B (1997): 37-48.

Hurd, Michael, D., Pierre-Carl Michaud, and Susann Rohwedder. "The Lifetime Risk of Nursing Home Use." In *Discoveries in the Economics of Aging*, edited by David A. Wise, 81-109. University of Chicago Press, 2014.

Kapteyn, Arie, Pierre-Carl Michaud, James Smith, and Arthur van Soest. "Effects of Attrition and Non-Response in the Health and Retirement Study." *Institute for the Study of Labor Discussion Paper No. 2246*, 2006.

Kemper, Peter, and Christopher M. Murtaugh. "Lifetime Use of Nursing Home Care." *New England Journal of Medicine* 324, no. 9 (1991): 595-600.

Lakdawalla, Darius, and Tomas Philipson. "The Rise in Old-Age Longevity and the Market for Long-Term Care." *American Economic Review* 92, no. 1 (2002): 295-306.

Li, Minghui, Ilene Harris, and Z. Kevin Lu. "Differences in Proxy-Reported and Patient-Reported Outcomes: Assessing Health and Functional Status Among Medicare Beneficiaries." *BMC Medical Research Methodology* 15, no. 62 (2015).

Lusardi, Annamaria, and Olivia S Mitchell. "Baby Boomer Retirement Security: The Roles of Planning, Financial Literacy, and Housing Wealth." *Journal of Monetary Economics* 54, no. 1 (2007): 205-24.

Magaziner, J, SI Zimmerman, AL Gruber-Baldini, JR Hebel, and KM Fox. "Proxy Reporting in Five Areas of Functional Status. Comparison with Self-Reports and Observations of Performance." *American Journal of Epidemiology* 146, no. 5 (1997): 418-28.

Murtaugh, Christopher M., Peter Kemper, and Brenda C. Spillman. "Risky Business: Long-Term Care Insurance Underwriting." *Inquiry* 32, no. 3 (1995): 271-284.

Nordman, Eric C. *The State of Long-Term Care Insurance: The Market, Challenges and Future Innovations.* National Association of Insurance Commissioners and the Center for Insurance Policy and Research, 2016.

Ofstedal, Mary Beth, Gwenith G. Fisher, and A. Regula Herzog. "Documentation of Cognitive Functioning Measures in the Health and Retirement Study." *HRS Documentation Report DR-006*, 2005.

Pauly, Mark V. "The Rational Nonpurchase of Long-Term Care Insurance." *Journal of Political Economy* 98, no. 1 (1990): 153-168.

Rodriguez, German. *Lecture Notes on Generalized Linear Models.* 2007.

Singh, Emily. *Is Long-Term Care Insurance Underwriting Getting Easier?* April 22, 2016. https://www.ltcipartners.com/blog/is-long-term-care-insurance-underwriting-getting-easier (accessed September 12, 2017).

Society of Actuaries. "Section 55PD: Long-Term Care Underwriting." *RECORD, Volume 25, No. 2, Seattle Spring Meeting, June 16-18, 1999.* 2000.

—. "Session 14 PD, Older Age Mortality and Cognitive Testing." *Life & Annuity Symposium.* 2014.

Wilkin, John C., Geoffrey R. Hileman, and James S. Genuardi. *Analysis of Long-Term Care Insurance Experience for Insureds by Diagnosis at Issue.* Society of Actuaries, 2007.