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Cognition, Liquidity and Lapse of Long-Term Care Insurance: Evidence from the Health and Retirement Study

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Abstract: Private long-term care insurance (LTCI) market can play an important role in promoting the financial security of long-term care expenses for older adults in the US. However, the problem of underinsurance and termination of existing LTCI policies contribute to uncertainty and challenges associated with one of largest financial risks that today's elderly are facing. I use longitudinal data from the Health and Retirement Study (HRS) to examine the relationship between consumer competency, liquidity and policy lapse decision. Facing with the complexity of LTCI products and the financial burden of premium payment, consumer competency (measured by numeracy and executive function) and liquidity appear to be significant predictors of policy lapse decision. These findings suggest policy lapse relates to consumer competency and financial circumstances more than to reassessment of health risks. This is consistent with a view that many senior citizens have difficulty in evaluating financial implications of insurance decisions due to lack of performing numeric calculations correctly or high-level thinking abilities. Conditional on the controls that insurers use for pricing LTCI policies, those who lapse the coverage are more likely to use nursing home care compared to those who retain, supporting the evidence of *advantageous* selection in the market.

Keywords: long-term care insurance, advantageous selection, lapse, nursing home use, numeric ability, executive function

JEL Classification: I13; C11; C18; H

1. Introduction

The financing of long-term care services and supports (LTSS) represents a significant financial uncertainty for the elderly as the US population ages and the demand for LTSS continues to grow. Approximately $339 billion, or about 14% of all healthcare spending in the US, was consumed by LTSS in 2013 (Colello and Talaga, 2015)[1] and this number is increased to $400 billion per year in 2019 (Tennyson & Yang 2014). Favreault and Dey (2016) projected that formal LTSS will cost, on average, $138,000 per person turning 65 in 2015-2019, expressed in 2015 dollars. These costs are largely driven by nursing home care, where the average daily rate for a private room was $253 or over $97,000 annually in 2017 (AARP, 2018). Medicaid, the largest public payer, accounts for 44% of total long-term care expenditures (Frank 2012). About 20% of LTSS costs are financed through out-of-pocket with less than 10% of individuals own a private long-term care insurance (LTCI) policy (Brown & Finkelstein, 2007; Munnell et al., 2009). Therefore, long-term care is arguably the single largest uninsured health risks facing the elderly in the US.

Private LTCI can play a role in financing one's LTSS needs and promote the insurability of long-term care in the US. The limited market size, and policy termination have been the subject of substantial research and policy attention. Various policy initiatives have been implemented to improve the take-up rates of private LTCI coverage, including federal-state tax incentives (Goda 2011), the establishment of a collaborative partnership between states and private insurers for long-term care coverage (Lin and Prince, 2013). These policy initiatives certainly aim to promote a combined approach where both public and private coverage play important roles in addressing financial challenge associated with long-term care expenditures. There is a well-developed literature that shows why so few people own private LTCI plans to insure themselves against one of the largest financial risks in the US. Those studies have offered potential explanations including both demand and supply side factors. On the demand-side, the presence of Medicaid as a potential LTCI option may crowd-out the private LTCI market (Brown, Coe et al. 2006, Brown and Finkelstein 2007, Brown and Finkelstein 2008, Brown and Finkelstein 2009). Other demand-side factors include bequest motive, availability of informal care, expectations about future use of LTSS and experience with long-term care system (Finkelstein and McGarry 2006, Brown and Finkelstein 2011, Coe, Skira et al. 2015). On the other hand, high transaction costs, information asymmetry, imperfect market competition and dynamic contracting problems are some of supply side factors cited to explain the limited market size (Finkelstein and McGarry 2006, Brown and Finkelstein 2007).

An area that has not gained much attention in efforts to expand private LTCI market is the voluntary termination of an existing LTCI policy and the relationship between policy lapse and the future use of LTSS. There is a wide variation of existing estimates of lapse rates. Multitude of factrors are responsible for this variation including the use of data resoruces and how policy lapse is measured. For example, lapse rate is estimated as 5.4% based on 14 of the largest long-term care insurance companies (Purushotham, Douglas et al. 2004), while it is as high as 10-30% in population based data (Scanlon 2000, Konetzka and Luo 2011). But recent evidence suggests a lower trend in policy lapse rates (Li and Jensen 2012).

Individuals may let their policies lapse due to changes in financial circumstances which make an existing policy unaffordable, poor cognitive ability (components of global cognition such as executive function or word recall abilities), numeracy or the ability to understand and perform numeric calculation. If the key public policy question is to align incentives across public and private sources towards a more sustainable financing option for long-term care expenditures, then expansion of LTCI coverage among marginal buyers who will eventually drop out from the market will unlikely solve the financing challenge. Furthermore, if the policy lapse rates are higher among individuals who will likely use LTSS in the future, then it could exacerbate the financing challenges. Therefore, an important policy question is who benefits from private LTCI and the relationship between policy lapse and the future use of LTSS.

Follwing exisiting literautre on consumer competency and its impacts on economic decisions, I define numeracy as one's abiltiy to understand and manipulate numbers and executive fucntion as one's higher-level thinking abililities including solving complex tasks, mental manipulation of ideas and the processing critical information. In keeping with Knickman & Snell (2002), I consider older adults' financial circumstances based on liquid assets that determines individual's financial viability to absorb long-term care shock which is likely impact lapsing decision. To examine, the role of consumer competency and financial circusmtanaces on LTCI policy lapsing, I estiamte a

bianry probit model to predict the optimal lapsing decision. I then attempt to identify the characteristics of individuals for whom the observed policy lapse differs from the predicted lapse, which is analogous to the analysis of suspect choice in Bernheim & Rangel (2009).

I find that individuals with higher numeracy score and executive functioning are less likely to lapse a LTIC policy. These results suggest that the ability to understand and manipulate numeric calculations and higher-level executive function are important predictors of policy lapse decision. Similarly individuals with liquid assets less then $50,000 were more likely to lapse suggesting that they will likely have no choice but to rely on Medicaid for LTSS in the future. On the other hand, individuals with liquidity between $50,000 and $150,000 were less likely to lapse, supporting the idea for delivering the LTCI plan products more attractive for middle-income and asset group people in order to improve financail security of LTSS expenses for this group of people. Finally, the positive relationship between lapsing and future use of nursing home care supports the idea that who lapsed LTCI policy are *ex-post* revealed to be at higher risk of using LTSS in the future than those who maintained the coverage.

2. Background of LTCI

Unlike acute care, LTCI coverage helps individuals pay for personal, nursing and other support services when the ability to self-care has diminished due to chronic illness, disability or dementia. Typical LTSS covered by a LTCI policy range from performing daily living activities such as bathing, eating, dressing and walking or instrumental activities such as taking medications, preparing meals or grocery shopping. This type of assistance is usually provided at home or in institutional settings such as nursing homes or assisted living facilities. Nearly two-thirds of all active LTCI policies is purchased on an individual basis while only one-third is purchased though employer-sponsored group coverage (Mulvey 2009). LTCI contracts have a very long duration period; as such, LTSS claims may occur as late as 25 years or more after policies are purchased.[2] Policy premiums can depend on a variety of factors including age and health status when the policy is purchased as well as benefit options that are being selected. For example, average annual premium can range from $5,331 to $9,206 with the same benefits options (i.e. 5% inflation protection and $200 daily benefit) if the policy is purchased at age of 60 versus at age of 70 (NAIC, 2016). Although coverage is guaranteed to be renewable at a fixed premium, an increase in premiums is almost inevitable for a “class of policy holders”, as LTCI companies don’t have the right to increase premium for a single policyholder. Many policyholders in recent years have been affected by premium increase, with an average increase of 83% in 2016 (Ujvari 2018). For example, Genworth increased premiums for their LTCI policies about 60% in the state of New York in 2015 (Genworth Financial Inc, 2015). In case of premium increase, policyholders are given the option of lowering benefits to keep premiums fairly at the same level. However, in most cases, lapse becomes an obvious choice for those who can't afford to pay the increased premium to maintain the same coverage level because of lowering benefit structure may not be economically justifiable. Furthermore, LTCI benefits become more restrictive in terms of cost-sharing of the policyholder. For example, today’s policies have dramatically longer elimination period[3] and lower benefits duration[i] compared to policies of the past (Li and Jensen, 2012). A decade ago, 10% of policies sold had a two-year duration, but nearly 20% now do so (LifePlans Inc, 2017). Also, average daily benefits have increased only 5% over last five years, while in earlier periods, daily benefit amounts increased between 20 to 30% over each five-year period (LifePlans Inc, 2017).

Because of the long-term nature of these contracts, it is important the policyholders understand the risks of accurate prediction of care needs in the future, costs of such as in addition to rising premium to keep the policy in force (Weston 2012). Therefore, the policy renewal decision can be complex given the changing landscape of the private LTCI market and product complexities. Assessing the value of an existing LTCI policy demands significant numeric skills and high-level thinking abilities to solve complex tasks such as calculation of expected costs of paying premiums versus benefits from the policy in present dollar terms, assessing the need for care use in the future, evaluating financial circumstances in terms of liquid assets, possibility of self-insurance and perhaps "spending-down" assets and income to meet Medicaid eligibility. Previous evidence suggests that consumers' numeric skills, and cognitive ability are significant predictors of positive retirement outcomes, including wealth accumulation, retirement savings (Smith, McArdle and Wills 2010; Peters et al., 2007) health insurance decisions (Chan and Elbel, 2012; Kuye et al., 2013).

3. Literature Review

Historically, it has been difficult to examine LTCI lapse decision based on insurer data because there is no efficient way to define whether the policy lapse is due to death or nonpayment of premium (LTC Intercompany Experience Study, 2011). However, understanding lapsing behavior is important in the LTCI market as this type of coverage is expensive and lapsing may significantly reduce the expected future benefits (Brown and Finkelstein (2007). While investigating policy lapse decision, most of the existing literature has used LTCI ownership questions asked in the Health and Retirement Study (HRS) data. While this type of micro-level insurance question is ideal for examining lapsing behavior, but LTCI ownership questions in the HRS survey have changed in ways that could substantially impact the results of predicting lapse and evidence of risk selection. For example, from HRS 1996-2000; the exact wording of the LTCI ownership question was; "Do you have a LTCI?" Measuring lapse based on this ownership question is problematic because there is a misconception among the elderly that Medicare covers long-term care (Scanlon, 1998) and it is possible that HRS respondents referred to any other government insurance programs when asked about the LTCI ownership question. Because of this possibility, the HRS starting from 2002 wave asked an additional follow-up question to clarify whether respondents referred to a LTCI ownership or any other private or government sponsored program. Specifically, after the initial LTCI ownership question, respondents were asked "*Is it one of the plans that you told me about previously?"* This follow-up question helped to determine prevalence of LTCI ownership among HRS respondents more precisely. Therefore, examining lapse prior HRS-2002 wave may overestimate lapse rates due to lack of clarity in the LTCI ownership question.

Another set of studies that investigated lapsing behavior using a direct survey question that was being asked prior HRS 2002 wave. The question reads as "*Have you ever been covered by any long-term care insurance that you cancelled or let lapse?"* Finkelstein & McGarry, (2005) found that those *who reported "ever lapsing" a LTCI in 1996, only 20% again reported "ever lapsing" a policy in 1998, indicating a high possibility of measurement error with this survey question.* Later the HRS has dropped this survey instrument after 2002 wave. Therefore, studies based on this survey question have also raised concerns about the validity of this instrument. Until recently only three studies that used HRS 2002 or later waves data to investigate and risk selection test as listed in Table 1.

The current article is related to three recent studies (Lin and Jensen 2012; Konetzka and Luo, 2011; Cramer and Jensen, 2007) that investigated lapsing using a "point-in-time" measure where policy lapse is defined by having a LTCI in one HRS survey wave but not in the immediate next one. Konetzka and Luo, (2011) examined lapsing and its relationship with future care use using HRS data from 1996 to 2006. But it was not clear how the authors have used pre and post HRS 2002 LTCI ownership questions while defining lapse which could potentially impacts the study findings. Lin and Jensen (2012) report that a lack of consumer awareness of LTCI policy features including benefit structures (e.g. how generous the policy is) and prior encounters with the long-term care system are significant predictors of policy lapsing. Using HRS 2002-2004 waves Cramer and Jensen (2007) find that 15% of individuals reported lapsed of an existing LTCI policies between 2002 and 2004 and financial circumstances played an important role in policy lapsing decision in addition to limitation in activity in daily livings (ADLs). Friedberg et al. (2017) recently examines lapsing decision by defining lapse, if a policyholder terminated a LTCI policy between 2002 and 2006 that was purchased in 2002. However, defining policy lapse this way ignores the longitudinal nature of the HRS data and an inter-temporal decision-making framework where at each time point a policyholder makes the renewal decision. The authors find that financial burden and cognitive ability are the two important predictors of lapsing. In addition, the authors use the global cognitive score as a measure of cognition. Recent evidence suggests that consumer numeracy skill (ability to perform mathematical calculations) is a significant predictor of LTCI purchase decision. Furthermore, components of cognition such as executive function or recall ability may have differential impacts on insurance choices. Therefore, accounting for components of cognitive ability and numeric skills on policy lapse decision will allow us better understanding of individual characteristics that may distort LTCI coverage choices even after purchase so that appropriate policy initiatives can be implemented.

While examining the evidence of risk selection, the current paper relates to Finkelstein & McGarry (2005) and Friedberg et al. (2017) who studied risk selection and its sources. Using the direct lapse question in HRS 1996 wave, Finkelstein & McGarry (2006) found that those who lapsed their policies were on average 2.4 percentage points less likely to use long-term care in the future. However, as noted previously that this direct lapse question is likely subject to high measurement error and therefore this finding may be inconclusive. Recently Friedberg et al. (2017) examine the relationship between policy lapse and future use of nursing home care. The authors find that those who lapsed coverage are more likely to use nursing home care compared to those who retain coverage, supporting *advantageous* selection in the market. However, the authors used the same set of control variables predicting lapse and nursing home care use while control variables in predicting future care utilization should account for variables that insurers use for pricing a policy as suggested by Finkelstein & McGarry (2005). Because of the same controls used in both (lapse and care use) regressions, the coefficient estimate of an indicator variable lapse in the nursing home care regression should be interpreted as the difference between two policyholders with the same financial circumstances, cognitive ability or expected risks, but one lapsed coverage and the other maintained it. Following Finkelstein & McGarry (2005), I estimate the relationship between lapsing and future nursing home use with and without control variables (only those that insurers are allowed to use for pricing of a policy) and a more robust approach by including predicted lapse indicator with and without control variables.

The current study contributes to the existing literature in several ways. First, using HRS 2002-2008 that include clarified questions of LTCI ownership, I focus on consumer competency in two

ways: numeracy and multidimensional measures of cognition instead the global cognitive function. This is because navigating the LTCI market can be complex and policy renewal decision presents significant demands on a policyholder's ability to understand and manipulate numbers. Therefore, it is reasonable to expect that numeric ability as a significant predictor of lapsing decision. Furthermore, components of global cognition may have different effects on lapsing behavior, yet literature largely focus overall cognition and ignore components of cognitive status. For example, executive functions are responsible for tasks such as reasoning, planning, decision-making and management of the individual's own life (Swami, 2013). Because it is the management system of the brain, impairments in executive functioning can have major impacts on one's ability to make a complex financial decision such as LTCI policy renewal. Estimating independent effects of components of overall cognitive ability and numeracy on lapsing is important in efforts to formulate appropriate strategies that improve simplification of LTCI products and promote effective consumer choices. While this is more likely to be a potential solution in the short run so that older adults are not likely to be overwhelmed by the complexity of LTCI options (as it is difficult to improve numeracy skills or executive function in short-period of time) but future interventions to improve numeric ability and high-level thinking abilities to solve complex tasks in general population can be effective in the longer run. Second, I use specific threshold values for liquid assets based on the long-term care financing model to examine the level of financial commitment that older adults need while considering private LTCI as a viable financing option and avoid any potential loss of paid premium due to lapsing. For example, whether individuals in the middle income/asset group are less likely to lapse coverage would be important to know as recent policy initiatives, such as partnership LTCI coverage, are intended to promote the uptake of LTCI among middle income group individuals with a goal to promote financial security of long-term care financing for this group. Third, I examine whether word recall abilities or self-reported memory are the sources of the risk selection because these are the two HRS measures that closely correspond to multi-item instrument that insurance underwriting models use to predict future cognitive decline and likely use of nursing home care (Cornell et al., 2016).

4. Conceptual Model

Consider a LTCI policy renewal decision in the context of an inter-temporal decision-making framework where in each year a policyholder either renews the policy by paying premiums or terminates the policy (forfeiting paid premiums) and faces the same financial risk of future LTSS use. Theoretically, a typical LTCI policyholder will make an optimal decision to lapse the policy if and only if the expected utility from terminating the LTCI policy is greater than the expected costs of retaining the policy (in terms of premium payment). Given the inherent risks and uncertainties associated with LTCI coverage (Brewster & Gutterman, 2014), the renewal process involves complex financial calculations including determination of expected costs of premium over time versus expected benefits in terms of payments for LTSS use, probability of needing LTSS in the future or potential transition to Medicaid status based on current asset/income decumulation. This complex decision process entails a policyholder's ability to manipulate numbers and evaluate the alternative based on sound financial reasoning. Evidence suggests that numeric ability is a predictive of better decision-making performance even after controlling for educational attainment (Wood et al., 2011). Recently, McGarry et al., (2018) finds that poor numeracy skill represents a significant barrier to LTCI policy purchase decision. Using three different measures of cognition (word recall, mental status and numeracy), Smith, McArdle and Wills (2010) find that both word recall abilities, mental status and numeracy significantly impact

financial wealth and participation in stock market and better portfolio management among HRS respondents. Existing work suggests that executive function, an important component of global cognition, is tightly correlated with working memory that controls the higher-level thinking abilities, reasoning, mental manipulation of ideas, future planning and help individuals carrying complex tasks (Diamond, 2013; Garcia-Madruga et al., 2016; Morris and Ward, 2005). Furthermore, executive functioning has found to be responsible for controlling overall cognitive resources while solving difficult tasks (Rabinovici et al, 2015; Engle, 2002, Baddeley et al., 2000; Baddeley 2007). Collectively, the existing work suggests that executive function is critical that impacts one's ability to process complex information and decision-making and future planning. With this mind, I assume that executive function can predict lapsing decision. To better understand independent effects of numeracy and components of cognition, I test whether these individual characteristics predict lapsing behavior after controlling for educational attainment.

5. Data and Sample

Data for the current study were drawn from the Health and Retirement Study (HRS), a nationally representative panel survey of Americans age 50 years or older. The HRS is a biennial survey that includes sample respondents and their age-eligible spouses. The survey includes several cohorts including the original HRS cohort (born 1931-1941), the AHEAD cohort (born before 1924), the Children of the Depression cohort or CODA (born 1924-1931), the War Baby Cohort (born (1924-1947), Early Baby Boomers cohort (born 1948-1953) and the Mid-Baby Boomers cohort (born 1954-1959). These birth cohorts entered into the survey in different calendar years. The current study used the 2002-2008 waves of the HRS to examine policy lapse decision because starting from 2002, HRS respondents were asked about their ownerships of LTCI in such that *allows researchers to distinguish between participants who own private LTCI and those who think they carry LTCI but in fact do not*.

Beginning 2002, HRS participants were asked about their basic health insurance, including private and government-sponsored plans. The survey then asked *Not including government programs, do you have any LTCI which specifically covers nursing home care for a year or more, or any part of personal or medical care in your home*." If a respondent answered *"yes"* to this question, he or she was then asked whether this insurance is one of the plans that they already described earlier and, if so, to specify which plan. Respondents in the current study were classified as having a private LTCI if they acknowledged that they were not referring to any other insurance coverage but the LTCI. In 2002, approximately 20% of respondents indicated that they referred to other government programs (Medicare, Medicaid, VA etc.) and not the ownership of a private LTCI coverage when asked about LTCI ownership question and were excluded from the study sample.

The study sample was constructed by pooling all two-wave intervals where participants held a LTCI policy in the first period of any two-wave transition and must have been observed in any two consecutive survey waves (e.g. 2002-2004, 2004-2006 etc.). There are 3 transitions observed in the study period from 2002-2008 to define lapse. Among individuals age 50 or older, 1501 had long-term care insurance in 2002 for whom lapse could potentially be observed in 2004. Out of 1501, there were 101 individuals for whom LTCI holdings were not observed due to missing or ambiguous responses (e.g. "refused", or "don't know" or "missing") in 2004 LTCI questions and therefore excluded from the sample. The same method was used for other two transitions to construct the analytic sample. For example, about 1591 respondents in 2004 and 1603 individuals

in 2006 who identified as having a LTCI policy that they could potentially drop in 2006 or 2008. The sample also excluded individuals with proxy respondents as proxy respondents in the HRS sample participate on behalf of the respondents whose disability or impairments prevent them to respond survey questions accurately. The final analytic sample included 1975 unique individuals with 6724 person-year observations.

Although one can argue that defining lapse using "point-in-time" responses may include measurement error, it is arguably less subject to recall bias (Konetzka and Luo, (2011). Measuring lapse using cross-wave information on post-2002 data produce reasonable lapse rates (Li and Jensen 2012, Ujvari 2018) in the HRS data. For example, lapse rate over any two-year wave in the current study is 9.1%, compared to 2015 Society of Actuaries LTCI pricing study (Eaton 2016) using industry data as 8.5% for people aged 60 and above, 9.7% for those aged 70 and above and between 10 to 15% using the HRS data (Cramer and Jensen 2007, Li and Jensen 2012). Finkelstein, McGarry et al. (2015) pointed out that measuring lapse based on HRS cross-wave responses yield a very high lapse rates using pre-2002 data (as high as 50%), however, post-2002 data produce reasonable lapse rates comparable to industry data as well as other sources (SOA). Several robustness checks were performed to demonstrate the sensitivity of this measure as described in the Technical Appendix. RAND version-P of the HRS data was utilized in the current study.

6. Variables

6. 1. Outcome Variable

As discussed in the data description section above, a policy lapse was defined as having insurance in one period and not having it the next. When studying potential reasons for a policy lapse, it is important to match risk attributes to the timing of lapse decision. Measuring a policy lapse between two consecutive waves gives the opportunity to capture the risk profiles and other individual characteristics that could potentially contribute to the policy lapse decision.

6. 2. Key Independent Measures

Measures of liquidity constraint: As financial status of an individual can significantly impact his/her decision to purchase private LTCI (Chatterjee & Fan, 2017), it is also expected that individuals may lapse their policies due to increasing financial burden to pay policy premiums. The HRS includes approximately 20 components which provide a moderately detailed picture of household wealth and asset portfolio. The HRS measures of wealth have been widely used in the literature and considered to be of high quality (Venti 2011, Hurd, Meijer et al. 2016). Liquidity status was captured by two specific measures: liquid assets (or financial wealth) and total income. Liquid assets include non-retirement financial wealth, including stocks, bonds, checking accounts, CDs, and other assets (excluding retirement and housing wealth), net of associated debts. Following Knickman and Snell (2002), liquid financial assets was used to identify those who had: 1) less than $50,000; who will likely lack adequate financial resources needed for LTSS or to pay premium for long period of time and higher chance of relying on Medicaid in the future; 2) individuals whose liquid assets are adequate; between $50,000 and $150,000 but cannot absorb the long-term care shock; and, 3) individuals who had liquid asset more than $150,000 available for LTSS, who can self-finance LTSS without private insurance.[4] The CPI medical index was used for adjustment of long-term care expenditures for inflation, due to the focus on the out-of-pocket expenses when no long-term care coverage exists (Dunn et al., 2018). Indicators variables for those

had less than $50,000 and had liquid asset as more than $50,000 but less than $150,000 were included in the regression and the high asset group served as the reference group.

Because Medicaid eligibility is determined by both assets and income, and lapsing may be rational if a policy holder perceives that he/she will likely qualify for Medicaid in the future. Impacts of liquidity constraint and income on policy lapse will be informative to consumers and public payers for better understanding of financial security needed to maintain a LTCI policy and potential fiscal burden on the Medicaid. Keeping this in mind, I include total income in addition to liquid asset in the model. Total income consists of earned income, social security or pension income including annuity. To capture non-linear effects, it is categorized into low, medium and high groups; with low and medium groups were included in the regression, high representing as the reference category. Low income is defined as less than or equal to $25,000 per year, medium income as more than $25,000 but less than $75,000 and high as more than $75,000.

Measures of Cognitive ability: I attempt to estimate the impacts of two important components of global cognitive measure on policy lapse decision. Overall cognitive ability is multifaced that includes memory, executive function and verbal ability which may have differential impacts on lapsing decision. I used two composite measures of overall cognitive ability that are available in the HRS data. These two measures include "executive function" or overall mental status and word recall abilities (both immediate and delayed recalls). The word recall measure ranges from 0-20 and mental status score ranges from 0-15. These two components have been used previously as a total cognition measure that captures an individual's overall cognitive ability to examine insurance decisions (McGarry et al., 2016; Chan and Elbel, 2012). Additional details of these two composite measures in the HRS data are included in the Appendix. HRS mental status score includes some simple mathematical calculation (subtraction) in addition to backward counting and some naming exercise.

Measure of Numeracy: While cognitive ability helps individuals to understand and process complex information, numeracy refers to one' ability to understand and calculate numbers and probabilities. Therefore, numeric skill is important for making choices that involve substantial financial calculation such as lapsing decision which demands on consumers' numeric ability to calculate the expected future benefits verses expected costs of associated with an existing policy. I use numeracy to examine its independent effect on lapsing behavior. Increasing evidence suggests that both cognitive ability and numeracy are important in health insurance purchase decisions (Smith, McArdle et al. 2010, Boyle, Yu et al. 2012, Chan and Elbel, 2012, Gamble, Boyle et al. 2015, McGarry et al., 2018). Whether the policy lapse was impacted by an individual's ability to manipulate numbers or understand financial consequences is important to know because various educational intervention targeted to improve those skills in the long run that may induce people make better decisions while in the short-run, policy initiatives should focus on LTCI products simplifications so that lack of numeracy will not be a barrier to policyholders while making LTCI coverage renewal choices.

Control variables: The analytic model accounted for a variety of individual-level characteristics that economic theory or previous empirical literature suggests are important determinants of policy lapse decision. Specifically, I include demographic factors such as age, gender, race/ethnicity, marital status and education. Physical health, functional status as measured by the activities of daily limitations (ADLs), difficulty in managing money are also included in the model. To control for time effects on lapsing decision, age and HRS birth cohorts were included (alternatively)

instead time dummies due to limited calendar year window over which the policy lapse was examined. Any potential cohort differences in terms of financial resources and health related factors may be of interest to examine. For example, the relationship between financial wealth and lapse may vary by age group as lower financial wealth at very old age (say at 90) may indicate that individuals have used resources optimally. As suggested by Cornell et al. (2016) due to restrictive underwriting criteria in the long-term care insurance market, the existing pool of policy holders are healthier; therefore, the measuring control variables at the time of lapse would be reasonable.

Finally, two individual-level variables included as controls in the analysis are future expectation of needing long-term care and the availability of informal care in the future. While one's level of risk tolerance is likely to predict insurance purchase decision, perceived risk of future care needs may likely predict the policy renewal decision. I capture the expected future risk of needing LTSS by using an HRS variable that measures self-assessed probability of needing nursing home care in next 5 years for respondents 65 years or older. Based on the previous literature, I assume that expected probability of using nursing home care in 5 years is zero for respondents less than 65 years old (McGarry et al., 2018). Future availability of informal care is captured by a yes/no question asked in the survey if respondents anticipate that friends or family members will provide long-term care should they need in the future.

7. Econometric Framework

This section presents the econometric approach to examine lapsing decision and the test for risk selection in the long-term care insurance market. Technical Appendix A discusses additional theoretical motivation behind the decision to terminate an existing LTCI policy based on a standard expected utility model of demand for health insurance.

To examine why people let their LTCI policies lapse, the following probit model was estimated:

$$\Pr(lapse_i = 1) = \phi(X_i\beta + \varepsilon_i);\ \varepsilon_i \sim N(0,1) \quad (1)$$

where the outcome variable of interest takes the value of 1, if the policy lapse is observed during each of two-year transition from 2002-2008; or zero, otherwise. The vector X_i includes key independent variables that would predict the probability of lapse and discussed in the variable description section above. Measurement of independent predictors at the time of lapse is motivated by the fact that long-term care policies are only offered to people with good health status to be eligible for the coverage (Hendren, 2013). The results from this probit regression are shown in Table 3.

Health insurance decisions are inherently complicated, there is a large literature documenting poor decision making among many health insurance enrollees. Following this literature, one underlying mechanism whereby numeracy or components of cognitive ability may influence lapsing decision is in the propensity to make mistakes regarding policy renewals. Specifically, I hypothesize that policyholders with greater numeracy skill or higher executive function will tend to make fewer mistakes in their LTCI policy renewal decisions.

I denote, $\widehat{y_i}$ as an indicator for deviations between the observed and predicted lapse which I denote as "suspect" choice.

$$\widehat{y_i} = \begin{cases} 1, \text{if oberved lapse differs from predicted lapse;} \\ 0 \text{ if observed lapse is as predicted} \end{cases}$$

Denoting y_i^* is the latent underlying $\widehat{y_i}$, I am interested in estimating the equation

$$y_i^* = \alpha z_i + \epsilon_{ij} \quad (2)$$

where z_i denotes individual characteristics including numeracy and components of cognitive ability (executive function and word recall abilities). The results of this regression are shown in Table 4. This indicator of suspect choice tests whether policyholders are making the lapse decision that cannot be rationalized based on a standard utility maximizing behavior for insurance decision under full information and has previously been used in the literature in the context of health insurance plan choice (Kuminoff, and Powers' 2015; Gruber 2011). I find that policyholders with higher score on mental status/executive function are less likely to make suspect choice suggesting that individuals with higher level of executive functioning are better able to make a choice that is more consistent with their preferences. These results are shown in Table 4.

To examine the evidence of risk selection in the market, I examine the relationship between nursing home care use (any nursing home stay) during 2010-2014 and lapsing. The test of risk selection was performed by two ways: 1) the first approach was to estimate the following regression (equation 3) with or without the control variables (Finkelstein & McGarry, 2005); and 2) a more robust approach is used by estimating how *predicted lapse (with and without controls)* impacts nursing home care use.

$$\Pr(Care_i = 1) = \phi(X_i\alpha_1 + \alpha_2 lapse_i + \varepsilon_i); \quad (3)$$

where, $Care_i$ indicates whether an individual received any nursing home care after the policy lapse, *lapse* indicates if individual lapsed the policy during 2002- 2008 and X_i includes a vector of individual characteristics of a typical LTCI applicant as used by the long-term care insurer to predict expected nursing home use such as age, gender, number of IADL limitations, number of ADL limitations, presence of cognitive impairment (Finkelstein and McGarry, 2003). Subscript i denotes individual policyholder.

Due to longitudinal nature of the data, some respondents appear in the analytic sample multiple time points. Regression models adjusted for this type of "clustering" in the data, specifically by allowing for intra-correlated errors to account for sample policyholders observed at different points in time. Accordingly, cluster-robust standard errors are reported in all regression results. All regression estimations are also adjusted for HRS probability weights to reflect complex multistage sampling design for the HRS data and to make the sample nationally representative.

8. Results

Table 2 shows the sample descriptive between two groups, those who lapsed versus those who retained LTCI coverage. Overall, lapse rate in the sample is about 9% consistent with recent estimates of lapse rates in HRS 2002 or later wave data (Cramer & Jensen, 2008; Li & Jensen, 2012; Friedberg et al., 2017). Comparing by each two-period, these rates 10.1% (between 2002 and 2004), 8.3% (between 2004 and 2006) and 8.9% respectively (between 2006 and 2008). On average, lapsers have lower scores on numeracy (1.65), mental status or executive function (10.90), word recall (10.02) and overall cognitive score (15.6) compared to non-lapsers (1.92, 11.82, 10.86 and 17.1 respectively). Bivariate relationship (using the analysis of variance) indicates that the mean values of mental status, word recall, and numeracy scores significantly vary by lapse status. Bivariate results also indicate that lapse rates vary significantly across numeracy scores with 7% of those with 2 or higher numeracy scores versus 16% and 10% with 0 and 1 numeracy scores who lapsed coverage.

While examining lapse rates across liquid asset groups, 55% individuals having liquid assets less than $55,000 lapsed the policy versus only 21% those who had more than $50,000 but less than $100,000 (same is true for income groups). This suggests that LTCI policy should target the middle-income group as they would need the coverage most compared to lower or high income/asset group. Comparing health and functional status, lasers were less likely to have a college education, were more likely to have ADL limitations, and difficulty in managing money compared to non-lapsers.

8. 1. Parameter Estimates of Probit Model Predicting Lapse

I use Stata 14 (STATA, Corporation, College Station, TX) as well as SAS 9.4 software (SAS Institute, Cary, NC) for statistical analyses. Table 3 presents marginal effects.[5] from probit regression that predicted the probability of lapsing (equation 1). Model 1 includes numeracy score along with financial wealth measures and other control variables. The finding suggests that numeracy score is a significant predictor of lapsing decision which is consistent with recent findings that numeric ability as a significant contributor of LTCI purchase decision (McGarry et al., 2016) as well as Medicare supplemental plan choice (Chan and Elbel, 2012). Model 2 includes mental status and word recall measures instead numeracy score and results suggest that for one standard deviation point increase in mental status score is associated with a 4 percentage point decrease in the likelihood of lapsing, and this effect is statistically significant but word recall does not appear to be a significant predictor of the likelihood of lapsing.

Policyholders having liquid assets less than $50,000 were 4% more likely to lapse a policy, while those who had assets between $50,000 and $150,000 were 2% less likely to lapse, compared to the reference groups (having liquid asset greater than $150,000). This result offers two important explanations. First, consistent with the current literature, it indicates that policyholders with liquidity constraint are more likely to lapse because of the financial burden of premiums over time. This could be because the policy was unaffordable to begin with or due to gradual decrease in wealth policyholders may find themselves to be eligible for Medicaid and therefore lapsing is a better choice for them rather spending resources for premiums payment. Second, the result that people in middle wealth categories (having liquid assets between $50,000 and $150,000) are less likely to lapse suggests that private LTCI should target middle income class families as they are

the ones who need this type of coverage most. Availability of informal caregiver in the future was associated with the higher likelihood of lapsing suggesting that people rely on family based informal care and consider unpaid care as an important source of LTSS should they require in the future.

Men were more likely to lapse a coverage while White, more educated, married were less likely to lapse. These findings are largely consistent with the descriptive results in terms of differences in characteristics between two groups as well as existing literature. When I replace the age groups with HRS birth cohorts, a strong "cohort" effect was observed. Specifically, Baby Boomers (cohort born between 1949 and 1959) were 6% less likely to lapse the coverage compared to all other HRS birth cohorts.[6] One potential explanation is the negative influence of normal aging on complex aspect of financial decision-making such as policy lapse decision. This also demonstrates significant differences in decision-making abilities of individuals of different birth cohorts and is consistent with the literature suggesting that aging can impact different aspects of financial decision-making abilities (Bangma et al., 2017).

I hypothesize that individuals with greater numeracy score and higher executive functioning will tend to make lapse decision more consistent with utility maximization assumption. To examine the characteristics of individuals how whom the observed lapse differs from predicted outcome, I use the outcome variable as an indicator for whether observed and predicted lapse diverge based on the individual's discounted expected utilities. Results suggest that individuals with a higher numeracy score and higher level of executive functioning are significantly less likely to deviate from predicted behavior. The marginal effect suggests that about 4 percentage point reduction in the probability of making a suspect choice for individuals with higher executive functioning skills. It is also evident that those who are in the middle asset group were less likely to make suboptimal decision regarding LTCI policy lapse. This may imply that these individuals understand that their liquid asset or income are high enough to be qualified for Medicaid, but they also can't absorb long-term care costs in the future. Therefore, they need some level of coverage protection for LTSS in the future. Finally, an interesting finding is that those who reported the availability of family-based informal care in the future are more likely to make suboptimal choice suggesting that older adults consider informal care as the primary source of LTSS which may not be consistent with the economic rationale which is consistent with the idea that recent demographic transition contributes to lower supply of informal care in the future.

A series of sensitivity analyses were also performed to ensure that results were not driven by exclusions or assumptions. Following Konetzka and Luo (2011), respondents were assumed to report their LTCI status correctly if they answered some follow-up questions about coverage benefits after the initial ownership question. Following a positive response of LTCI ownership question, they were asked if the policy included both nursing home and home health care, if benefits payments increase with inflation, if respondents received benefits under the existing policy, amount of premiums that they pay for the policy and how often payments are being paid. The main analyses were re-estimated on the subset of respondents who answered at least 3 out of 5 of these questions that were asked in all HRS waves. Results remained qualitatively similar to the main analyses (not presented and can be obtained from the author upon request). Second, a potential concern in the relationship between policy lapse and poor cognition be that insured individuals with low cognition are more likely to misreport the policy coverage information. A correlation test between cognitive scores and number of follow-up questions individuals responded

regarding the policy benefits options (such as whether policy has inflation protection, premium amount, premium payment structure, etc.) does not support that evidence (no statistically significant association was detected).

9. Evidence of Risk Selection

Considering a broader view of potential for risk selection in the long-term care insurance markets, the current study found evidence of advantageous selection leading to high-risk individuals who are dropping out of the market were more likely to use nursing home care in the future, controlling for factors that insurers use to assess risk of using care when issuing a policy. The detailed description of the sample construction for this estimation is described in technical appendix. Results are presented in Table 5. The nursing home care sample includes individuals who were at risk of using nursing home care between 2010 and 2014 among those who lapsed the LTCI coverage between 2002-2008. Excluding those who died between 2008 and 2010[6] the analytic sample for nursing home care use includes about 1674 unique members for whom potential care use could be observed after lapsing. Sample descriptive suggests that those who lapsed had significantly higher subsequent nursing home care use (19%), compared to non-lapsers (12%). This statistically significant difference may suggest the possibility of advantageous selection in the LTCI market

The second column (no controls) in Table 5 shows that those who lapsed their policies between 2002-2008 are, on average, 9% were more likely to use nursing home care during 2010-2014, compared to those who retained their policies. The third column reports results from the regression which controls for health-related factors used by the insurers while assessing risks of future long-term care use at the time of policy purchase. I use word recall and self-rated memory as measures of cognition because these are two variables available in the HRS that can are mostly closely related to measures that insurers use to predict cognitive decline over time as one of the important contributors of future LTSS use. The policy lapse variable on probability of nursing home care use remains statistically significant (a slight change in the magnitude). A positive correlation between policy lapse and higher likelihood of care use suggesting the evidence of advantageous selection in the LTCI market, which is consistent with findings in Medigap insurance market (Fang et al., 2006). Conditioning on the controls for the price of Medigap policy, the authors find that those with less health expenditure risks are more likely to purchase Medigap insurance. Recently, Friedberg et al., (2017) also find similar evidence while examining risk selection test. However, as mentioned earlier that the authors perform the risk selection test by using the same set controls that predicted lapse not the controls that insurers use for pricing the policy. As suggested by Finkelstein & McGarry (2006) that this type of risk selection should include only controls that are observable to the insurers and they are allowed to use for pricing the policy such age, gender, ADL limitations, cognition, not the full set of controls that are observable to the researchers. For example, LTCI policies are assumed to be purchased by people with relatively higher financial resources, therefore, insurers may not include the wealth or income measures in pricing the policy (which may be an important predictor for lapse). Rather policy pricing includes health risks factors that make someone is more likely to use care in the future. Therefore, it is not clear to what extent the choice of control variables contributed to the results of risk selection test in Friedberg et al. (2017). There is no significant association between either word recall ability or self-rated memory and future nursing home care use. Re-estimating the probability of nursing home care use regression with the predicted lapse[7] variable produces the qualitatively similar results.

10. Discussion and Conclusions

I use longitudinal HRS data to examine the predictors of a LTCI policy lapse and test the relationship between lapsing and the future use of nursing home care. Two important observations from the current study shed light on who benefits from a private LTCI coverage. First, the finding that individuals with liquid assets less than $50,000 probably be better off by not purchasing a private LTCI policy as they are more likely to lapse before receiving any benefits from the policy. For this group, private LTCI coverage may not be an effective financing option for LTSS due to financial burden of premium payment. These individuals may become eligible for Medicaid at some time in the future. Purchasing a LTCI policy would be a financial loss for them because when lapsation occurs individuals generally forfeit paid premiums as these policies usually do not include "non-forfeiture" option. On the other hand, the result that individuals with liquid assets between $50,000 and $150,000 are less likely to lapse, supports the idea that long-term care coverage should target this group of people whose assets are higher enough to qualify for Medicaid in the future but they are not able to self-finance the costs of long-term care either. Private-public partnership long-term care program, offering. hybrid LTCI products with annuities are some of the initiatives that have been proposed in recent years with a goal to attract middle-income/asset group who need the private long-term care coverage most.

Second, I find that executive function, an important component of global cognition, is significantly related to the likelihood of policy lapse decision suggesting that specific components of cognitive measure is more important than global measure. Furthermore, numeric ability appears to be significant predictor of lapsing behavior although the magnitude of the effect is smaller compared to executive function. Specific policy initiatives proposed at federal and state levels including LTCI products simplification to reduce strain on public budget and to increase costs covered by private policies should consider these important individual level characteristics. Because promoting consumers' numeric skills or executive function is likely not feasible in the short run.

I find no significant impact of perceived risk of needing long-term care on policy lapse decision as well as on the likelihood of future nursing home use. While previous literature finds that multidimensional private information related to an individual's risk type or preference is a significant predictor of insurance decisions, recent work suggests the importance of demand frictions such as limited cognitive ability while examining an individual's insuring behavior (Fang et al., 2008; Spinnewijn, 2016). Recently, Friedberg et al. (2017) also find little evidence on the relationship between subjective risk assessment and LTCI policy lapsing or future care use. The authors argue that financial ability and global cognition are more than risk reassessment that influence lapsing decision. The current study therefore is consistent with growing empirical literature and concludes that an individual's risk type or perceive risk assessment do not appear to be the source of advantageous selection in the long-term care insurance market.

Policy makers those who aim to strengthen the private long-term care insurance market, provide financial protection to older people and their families, and reduce the strain on public spending (Medicaid mainly) for LTSS have taken initiatives including, private-public partnership long-term care program, federal and state tax incentives, group coverage for federal employees. However, any such type of policy initiative should also consider the importance of numeracy and executive function in making policy renewal decision. The result that those with higher executive function are less likely to make "suspect choice" implies older adults need necessary skills to accurately evaluate the value of an existing policy or unable to perform this complex task. However, it is

difficult to improve these skills in the short run, so policy efforts should focus on restructuring the private long-term care insurance market by making LTCI products more affordable and simplified. The complexity of LTCI products appear to impose significant barriers to take-up rates as well distort choices after the purchase (Burns, 2006). There is a well-established literature (Gruber, 2011; Stromborm and Buchueller, 2002; Elbel and Schlesinger 2002; Frank and Lamirad 2009) that shows that complexity of health plan products induces errors in consumer decision-making. Therefore, simplifying LTCI plan products may promote effective consumer choices by demanding less numeric skills and high-level thinking abilities which many older adults lack and this type of initiatives are likely to be more effective rather interventions that try to improve numeric ability or executive functions among the elderly in the short-run. However, long-run initiatives should consider educational instruction or training on executive functions to promote efficiency in numeric ability and high-level thinking abilities necessary to solve complex tasks such as private LTCI choices that highly demand these abilities.

Apart from restructuring efforts in the private LTCI market, evidence suggests a growing need for resources to help older adults with their financial and healthcare choices including health insurance behaviors (MacLeod et al., 2017; Paez et al., 2014; Brown & Finkelstein, 2011). For example, LongTermCare.gov offers some educational resources on long-term care and how to finance it in the future but that information primarily targets potential buyers of LTCI policies regarding how to make the decision to purchase the policy. Any information related to policy renewal decision or possibility of policy lapse and potential reasons for lapsing could be relevant information for the site.

The current study has some limitations to note. Limitations include lack of supply-side data, that could potentially influence the policy lapse decision. One such important factor is the possibility of premium increase of an existing policy. Faced with increased premiums, lapse becomes an obvious choice for many policyholders who can't afford to pay the increased premiums. Second, trust and confidence on insurers in paying claims for LTSS use in the future. Policyholders may perceive the risk that insurers will deny claims as this can be a likely situation. About 30% of claims submitted between 2007-2008, on average, were denied (LifePlans Inc 2010). This is a very likely situation because these policies have been purchased decades ago and may contain out of date requirements for claiming benefits and the changes are not retroactive. Additionally, counter-party risk identified that insurers may be exiting the market at some point in the future may impact lapsing decision (Brown and Finkelstein 2011). The authors found that individuals having concerns about the financial stability of insurance companies are less likely to own a LTCI policy. However, these features of the private market are not controlled in the current study because of lack of appropriate data, which, in fact, are not readily available in any population-based survey database.

Nonetheless, findings of the current study have important implications for potential LTCI purchasers, insurers and public payers. The elderly considering financing long-term care needs through private LTCI policy are unaware about the possibility that initially affordable policies may become unaffordable in the future due to financial burden of premium payment. Policy renewal decision demands on consumer numeric ability as well as higher-level executive functions which may older adults may lack. Specifically, potential purchasers with liquidity constraint may want to seek additional advice and reconsider the decision to purchase a LTCI policy as they are at high risk for dropping the coverage before benefits trigger and likely to lose paid premium on the lapsed

policy. Making the LTCI products more simplified and attractive to consumers, increasing consumer protections to promote confidence in LTCI products, less strict underwriting practices are some of the initiatives that may improve financial security of LTSS expenses among older adults. For example, hybrid products that combine LTCI policies with either an annuity or a life insurance product through accelerated death benefit rider may prevent policy lapse as those products are easy to understand, offer some access to money and cost effective.

Endnotes

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1.Excluding Medicare expenditures, O'Shaughnessy (2013) estimates total spending for LTSS of $220 billion in 2011, or 9.3% all U.S. personal healthcare spending.
2.As suggested typical age of purchasing a LTCI is about 60 (Ujvari 2012) years and average age to a nursing home entry is about 85 years (Young, Kalamaras et al. 2015; Holup, Hyer et al. 2017)
3.Elimination period is the number of days after a policy holder will qualify for benefits. In general, most policies include a choice of elimination period that can range from zero to 180 days; but shorter the elimination period a policy holder will choose; the higher the premium will be.
4.This measure of financial status not only explains whether individuals with lower liquid assets are likely to lapse the policy but also indicates what level of financial wealth is required to retain a LTCI policy and to avoid potential financial loss due to policy lapse which could be an important information to know to begin with. The author defined long-term care financial viability based on costs of three-year nursing home supports in many parts of the country, based on the Lewin Long-Term Care Financing Model, expressed in 2000 dollars. According to this model, $150,000 was used to define a long-term care shock in 2000.
5.Marginal effects are computed by taking the average of discrete or partial effects of each of independent predictor variables on the probability of lapse (outcome variable taking the value of 1) for all observations and calculated by using "*margeff*" command in Stata which is a preferred approach than calculating marginal effects at means of the predictor variables (Bartus, 2005).
6.Including HRS birth cohort instead of age and time dummies. Coefficient estimates are not reported in the Table but can be found from author upon request. Marginal effects of other significant independent predictor variables remain qualitatively similar while including cohort instead of age groups in the estimation
7.Because it is not possible to determine when exactly someone lapsed the policy in the HRS data, it could be possible that policy was lapsed due to death, or the individual could have had a nursing home stay before death but it is difficult to determine whether the nursing home stay was after the policy lapse without knowing the exact time of policy lapse after 2008 but before 2010 interview.
8. Predicted lapse is also estimated with and without control

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Table 1. Studies using HRS LTCI holding and lapse questions in the literature

Studies	HRS data used in investigating lapse	
	HRS 2002 or prior waves	HRS 2002 or later waves only
Finkelstein & McGarry (2005) and Finkelstein, McGarry et al. (2006)	Investigated lapse using HRS waves 1996, 1998 and 2000 using ever reported lapse question; *outcome variable: ever lapsed*	
Mcnamara & Lee (2004)	HRS waves: 1996-2002 those who reported having long-term care insurance; outcome *variable: number of consecutive waves individuals held LTCI*	
Cramer & Jensen (2007)		HRS waves 2002-2004 those who reported having LTCI; *outcome variable: lapse between '02-'04*
Konetzka & Luo (2011)	HRS waves 1996-2006; outcome *variable: lapse between waves*;	
Li and Jensen (2012)		HRS waves 2002-2008; *outcome variable: lapse between each wave*
Friedberg et al. (2017)		HRS waves 2002-2006; *outcome variable: lapse between '02-'06*

Table 2: Descriptive Statistics of the Lapse Sample

Variable	Description	Full Sample	LTCI Lapsed	LTCI Retained	*p-value*
Age	In yrs. (50-100)	69.1(0.25)	69.75(0.57)	70.66(0.26	0.003
Male		0.41 (0.01)	0.41 (0.01)	0.43 (0.02)	0.19
Education	> 13 yrs. schooling	0.67(0.01)	0.54(0.02)	0.68(0.01)	<0.001
	HS diploma	0.27 (0.02)	0.30 (0.03)	0.26(0.01)	0.21
	< 12 yrs. schooling	0.07(0.01)	0.16(0.02)	0.07(0.01)	<0.001
Race	If White	0.97 (0.01)	0.93 (0.01)	0. 97(0.01)	0.01
	If Black	0.02(0.003)	0.07 (0.01)	0.02(0.01)	<0.01
Ethnicity	If Hispanic	0.01(0.00)	0.03 (0.01)	0.01 (0.003)	<0.01
Marital Status	If Married	0.70 (0.01)	0.57 (0.02)	0.72 (0.08)	<0.001
Numeracy	Numeric ability (0-3)	1.89(0.02)	1.65(0.03)	1.92 (0.02)	<0.01
Cognition	Word recall (0-20)	10.78(3.25)	10.02(3.5)	10.86(3.2)	<0.01
	Executive function (0-15)	11.74(3.65)	10.90(3.7)	11.82(3.6)	<0.01
Self-rated health	Fair/poor health	0.02(0.00)	0.05(0.01)	0.01(0.002)	<0.001
ADL Limitation	Any limitation	0.07(0.01)	0.11(0.01)	0.07(0.01)	<001
Handling money	Any difficulty	0.02(0.01)	0.05 (0.01)	0.02 (0.00)	<0.001
Self-assessed risk (Probability of entering nursing home in 5 yrs)	Low: $0< P \leq 10$	0.17(0.01)	0.13(0.01)	0.18(0.01)	0.03
	Medium: $10< P \leq 50$	0.21(0.01)	0.21 (0.02)	0.03(0.00)	<0.001
	High: $50< P \leq 100$	0.03(0.00)	0.03(0.01)	0.34(0.01)	0.69
Financial wealth: Liquid assets excluding housing wealth	Low: ≤$50,000	0.36(0.01)	0.55(0.02)	0.34(0.01)	<0.001
	Medium: >$50,000 but ≤$150,000	0.31(0.01)	0.21(0.02)	0.32(0.01)	<0.001

	High: >$150,000	0.41(0.01)	0.21(0.02)	0.34(0.01)	<0.001
Income/earnings	Low: ≤$25,000	0.13 (0.01)	0.21(0.03)	0.13(0.01)	<0.001
	Medium: >$25,000 but ≤$75,000	0.46(0.01)	0.49(0.03)	0.46(0.01)	0.64
	High: >$75,000	0.41(0.02)	0.29(0.04)	0.42(0.02)	<0.001
Future LTSS	Availability of family members to offer informal LTSS	0.52 (0.01)	0.63(0.03)	0.51 (0.01)	<0.001
Chronic health	# of conditions	1.6 (0.03)	1.5 (0.04)	1.8 (0.07)	0.008
Policy lapse (2002-2008) (N=1966)	If lapse in 2 yrs	0.19(0.01)	1	0	
NH care (N=1674)	If had overnight nursing stay between 2010-2014	0.14(0.01)	0.19(0.02)	0.12(0.01)	<0.001

Note: Descriptive statistics were calculated using HRS survey weights, standard errors are shown in parentheses.

Table 3. Marginal effects from the Probit Models of predicting lapse

Variables	Model 1	Model 2
Age: 66-74 yrs.	-0.02 (0.01)	0.05 (0.02)**
>74 yrs.	-0.01 (0.01)	0.07 (0.03)**
Male	0.04 (0.01)***	0.04 (0.01)***
White	-0.14 (0.04)***	-0.12 (0.04)***
Hispanic	0.11(0.06)	0.08 (0.06)
Married	-0.03 (0.01)**	-0.03 (0.01)**
College education	-0.01 (0.01)	-0.01 (0.01)
Financial wealth: ≤$50,000	0.03 (0.01)***	0.03 (0.01)***
>$50,000 - ≤$150,000	-0.02 (0.01)**	-0.02 (0.01)**
Income: ≤$25,000	0.03 (0.02)	0.03 (0.01)
>$25,000 - ≤$75,000	0.02 (0.01)*	0.02 (0.01)*
Numeracy	-0.01 (0.005)**	-
Executive Function	-	-0.04 (0.01)***
Word Recall	-	-0.002 (0.005)
Self-assessed NH risk: ≤10%	-0.01 (0.01)	-0.01 (0.01)
>10% ≤ 50%	-0.01 (0.01)	-0.01 (0.01)
ADL limitation	0.01 (0.02)	0.01 (0.02)
Future Availability of informal LTSS	0.02 (0.01)**	0.02 (0.01)**
Chronic conditions	0.007 (0.004)	0.007 (0.004)
Difficulty in handling money	0.02 (0.06)	0.02 (0.06)

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

Table 4: Marginal Effects of Suspect choice indicator-outcome variable: divergence between observed and predicted lapse

Variables	Model 1	Model 2
Age: 66-74 yrs.	-0.011(0.01)	0.04 (0.02)*
>74 yrs.	-0.02 (0.01)	0.07 (0.03)**
Male	0.03 (0.01)***	0.04 (0.01)***
White	-0.12 (0.04)***	-0.13 (0.04)***
Hispanic	0.07(0.05)	0.06(0.06)
Married	-0.03 (0.01)**	-0.03 (0.01)**
College education	-0.01 (0.01)	-0.01 (0.01)
Financial wealth: ≤$50,000	0.03 (0.01)***	0.03 (0.01)***
>$50,000 - ≤$150,000	-0.02 (0.01)**	-0.02 (0.01)**
Income: ≤$25,000	0.03 (0.02)	0.03 (0.02)*
>$25,000 - ≤$75,000	0.02 (0.01)*	0.02 (0.01)**
Numeracy	-0.01 (0.005)*	-
Executive Function	-	-0.04 (0.01)***
Word Recall	-	-0.001 (0.005)
Self-assessed NH risk: ≤10%	-0.01 (0.01)	-0.01 (0.01)
>10% ≤ 50%	-0.01 (0.01)	-0.01 (0.01)
ADL limitation	0.01 (0.02)	0.01 (0.02)
Future Availability of informal LTSS	0.02(0.01)**	0.02(0.001)**
Chronic conditions	0.007 (0.004)	0.007 (0.004)
Difficulty in handling money	0.02 (0.06)	0.02 (0.06)

Table 5. Relationship between policy lapse and future nursing home use

Dependent variable: Any use of nursing home care services between 2010-2014

Variables	No Controls	With control variables
Policy lapse (2002-2008)	0.091***(0.30)	0.067 (0.026)***
Word recall		-0.003 (0.002)
Self-rated memory-Good		-0.02(0.01)
Self-rated memory-fair/poor		-0.01 (0.02)
ADL limitations		0.07(0.03)**
Difficulty using money		-0.01(0.25)
Male		-0.04(0.01)***
Age		0.01 (0.001)***
Predicted lapse[b]	0.065***(0.01)	0.043(0.014)***

Notes: ****p<0.01; regression includes the set of control variables that insurers use to predict the likelihood of using long-term care use in the future such as physical and cognitive health status including subjective use of future nursing home use as suggested by Finkelstein and McGarry(2006);* [b]*predicted lapse was calculated after estimating the NH care regression with and without control variables.*

Supplemental Appendix

A.1 Theoretical Model of LTCI lapse decision

Consider that a typical policyholder, i does not earn any period income, distributes wealth W_i between consumption and paying premium for a LTCI policy. Let's also assume that the policyholder can be in one of the 5 possible health states in the future: 1) receiving no care; 2) receiving paid home care; 3) receiving care in an assisted living facility; 4) nursing home care; and 5) dead. The 3 middle states (2-4) require LTSS. Consider at any given time, $Q_{t,s}$ is the probability of a policy holder is in a health state s at time t given that the person was out of care at the time of purchase (the LTC policy requirement). The policy holder pays P_s as per-period premium which depends on the state of care because an individual does not pay premium if receiving care. After the initial purchase the policyholder may lapse the policy if he/she believes the risk of LTC utilization is low and saves the money that would have been spent on premium otherwise. However, the individual is exposed to the risk of out-of-pocket LTC expenditure in the next period, if needs care. Let's assume that $X_{t,s}$ is the total out-of-pocket costs for LTSS services and $B_{t,s}$ is the maximum benefits payable by the insurer, when needing LTSS. At each point in time when an premium for a policy renewal is due, the policy holder is making the optimal lapse decision by comparing expected utilities of retaining LTCI and terminating (or lapsing) the policy, denoted by EU_i^R and EU_i^L respectively.
The expected utility of retaining the LTCI policy can be written as

$$EU_i^R = \sum_{t=0}^{T} \beta \left[u_i\left(W_i - \sum_{s=1}^{5} Q_{t,s} \times P_s\right) + \sum_{s=1}^{s=5} Q_{t,s} \left\{ u_i \left(W_i - max\left(X_{t,s} - B_{t,s}, 0\right)\right)\right\}\right] \quad (1)$$

Similarly, expected utility of terminating the LTCI policy can be written as

$$EU_i^L = \sum_{t=0}^{T} \beta \left[u_i(W_i) + \sum_{s=1}^{s=5} Q_{t,s} \left\{ u_i\left(W_i - X_{t,s}\right)\right\}\right] \quad (2)$$

The policyholder will lapse the policy if and only if EU_i^L is greater than EU_i^R and will be

indifferent between two alternatives when

$$\Delta EU \equiv EU_i^R - EU_i^L = 0 \quad (3)$$

Assuming that an individual's propensity to lapse LTCI between any two time points, t to $t+1$ will depend on the latent net differences in expected utilities of retaining versus dropping the policy which is a function of one's expected cost and utilization of LTSS in the future, perceived risk of needing care, and other individual level characteristics including financial circumstances of the family. Denoting the observed indicator for LTCI lapse by l_i where

$$l_i = \begin{cases} 1 \; if \; \Delta EU_i \leq 0, and \\ 0 \qquad otherwise \end{cases}$$

The following reduced-form equation was estimated using probit model to test policy lapse decision:

$$l_i^* = \alpha_i + \beta_i X_i + \epsilon_i \quad (4)$$

where X_i denotes a vector of individual and household characteristics and ϵ_i is a random disturbance term drawn from the normal distribution. The outcome variable takes the value of 1 if a representative individual lapsed coverage between 2002 and 2012, or zero if he/she retained it.

A.2. Validation of the Lapse measure in the HRS sample

The outcome variable of the current study is constructed based on the HRS survey questions related to the prevalence of long-term care insurance (LTCI), which may be susceptible to measurement error due to self-reported nature of the survey instruments. However, it should be noted that the Health and Retirement Study (HRS) has been extensively used to examine issues related to LTCI (Brown JR, Coe NB et al. 2006, GS 2011, Coe NB, Goda GS et al. 2015, Gottlieb D and OS 2015, Cornell, Grabowski et al. 2016, McGarry, Temkin-Greener et al. 2016). The LTCI prevalence estimates derived from the HRS data has been found to corroborate to other national surveys and industry data (Brown, Goda et al. 2012, McGarry, Temkin-Greener et al. 2014, LifePlans 2017). Existing evidence suggests that HRS respondents could provide meaningful responses about LTCI ownership questions asked in the survey. As mentioned in the main section of this article, that beginning from HRS 2002, the survey asked follow-up questions (e.g. whether respondents refer to Medicare/Medicaid/ or any other private insurance coverage) to ensure the possibility of measurement error in the LTCI ownership estimate is minimal. In the current study two initial observations that increase the confidence that LTCI ownership questions are less likely subject to measurement error. First, those who retained LTCI are more likely to be college educated and wealthy compared those lapsed. It can be assumed that individuals with higher education are likely to improve financial decision making by acquiring basic knowledge and skills that they need to understand the choices that they face. That's why we observe that LTCI policyholders are typically highly educated as they understand financial consequences of purchasing such policy better and have the adequate level of financial resources compared to those with lower education. Also, individuals with better cognitive capabilities, measured by cognitive scores are likely to have the LTCI insurance. Second, the lapse variable is constructed based on "point-in-time" basis, meaning that respondents must have reported valid responses in both time period to be included into the study sample. I also included only if respondents had correctly identified LTCI ownership in both time periods. This approach arguably less subject to recall bias, however, additional validity measures would be important in the future.

A perfect dataset for measuring lapse is not currently available. One recent study by McGarry and Grabowski (2018) investigating the role of consumer numeracy skills on inflation protection take-up among LTCI policy holders found a good concordance in the trend of LTCI ownership with inflation protection features in the HRS with that of LifePlans data, which is the best source of publicly available data on LTCI ownership. This evidence offers the confidence that lapse measure based on LTCI ownership questions in the HRS are less likely involve measurement error.

To further explore the possibility of measurement error in the lapse variable, two sub population groups were considered. First, lapse rate was calculated for individuals who self-identified them as financial respondents in the HRS data. It is assumed that these individuals are most knowledgeable about the household's financial matters and therefore likely to accurately report the ownership of LTCI variable. Another group consists of individuals who responded their LTCI status are credible by answering detailed questions about LTCI policy benefit structure. Following a positive response of LTCI ownership question, individuals were asked if the policy included both nursing home and home health care, if benefits payments increase with inflation, if respondents

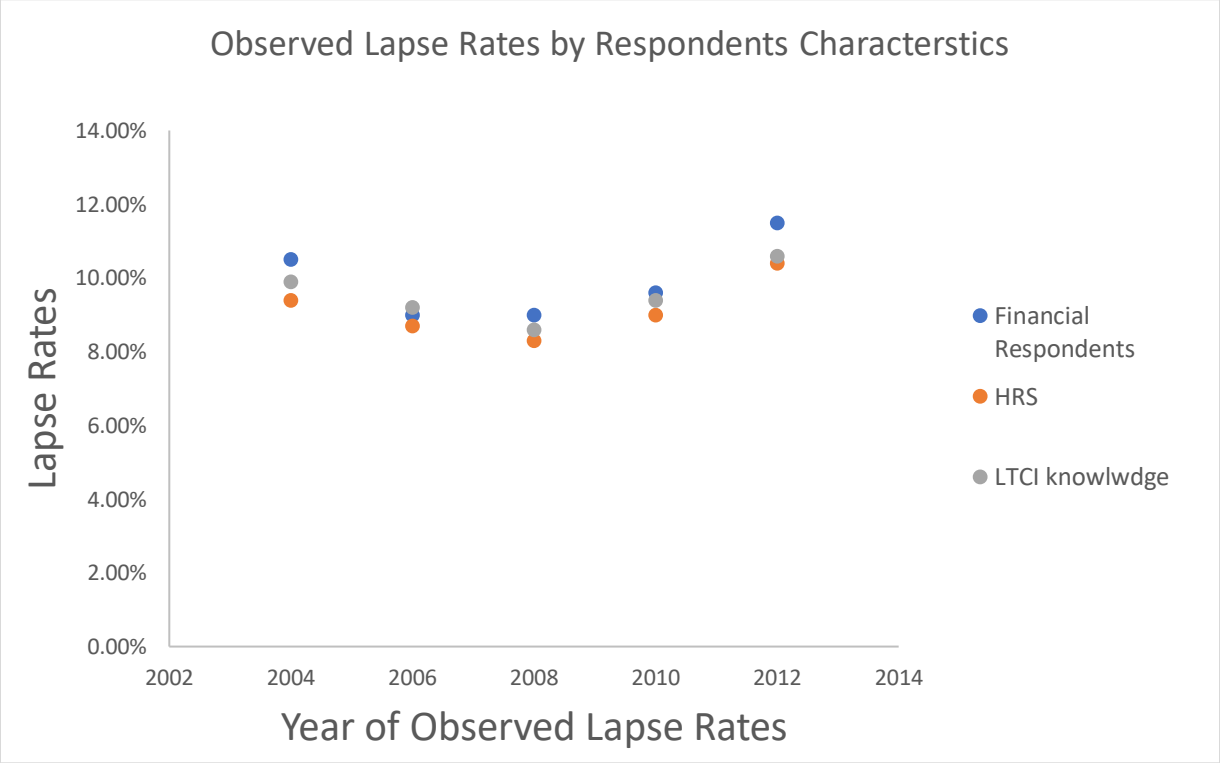
received benefits under the existing policy, amount of premium they pay for the policy and how often payments are made. The policy lapse rates for any two-year transition period from 2002 to 2012 waves in all three groups are overlaid in the Figure 1 which offers confidence that lapse variable constructed based on LTCI ownership data in the HRS can be used to address this research questions.

A.3. Additional details on nursing home care use sample construction

The lapse sample was created using the point-in-time definition in any two consecutive years. For this estimation each 2- year interval in the study period is considered as a transition from time 1 to time 2; i.e. 2002-2004 is one transition, 2004-2006 is another transition. The analytic dataset was created by pooling all 2-year transition and controlled for the calendar year in the regression analysis. Respondents who died in the second period of any two transition were also excluded from the study sample, as exact time of the policy lapse cannot be determined from the HRS data. This exclusion ensures that the policy lapse was not due to death.

Using a very similar sample construction that used in (Finkelstein, McGarry et al. 2005) paper for examining the relationship between policy lapse and future care use, there were 1966 individuals identified "at risk" of letting their policies lapse and who can be observed for subsequent nursing home care utilization between 2010 and 2014 after the policy lapse. There were 292 sample individuals who died before 2010, excluded from the nursing home care use sample, resulting 1673 sample respondents who were "at risk" of using nursing home care between 2010 and 2014.

Figure 1: Observed point-in-time lapse rates in HRS data from 2002-2012



Measures of Numeracy and Cognition in HRS data

Measure of Numeracy

The questions used to evaluate numeracy were added to the HRS in 2002 following question development by a team of researchers at the University of Michigan. Further information is available at (http://hrsonline.isr.umich.edu/sitedocs/userg/dr-006.pdf). The actual questions asked in the survey are below.

"Next I would like to ask you some questions which assess how people use numbers in everyday life. If the chance of getting a disease is 10 percent, how many people out of 1,000 would be expected to get the disease?"

"If 5 people all have the winning numbers in the lottery and the prize is two million dollars, how much will each of them get?"

"Let's say you have $200 in a savings account. The account earns ten percent interest per year. How much would you have in the account at the end of two years?"

Measures of Cognition

Word Recall and Executive Function Measures

Word recall ability in the HRS data ask respondents to recall as many words as possible from a list of 20 words at different time intervals. This measure aims to assess immediate and delayed recall abilities among respondents. The executive function or mental status measure evaluates working memory which includes serial 7's test where respondents are required to consecutively subtract seven from a given number for 5 iterations. Additional questions involving backward counting from 20 (assess attention and processing speed), date and naming, names of current president and vice president are also asked to assess executive function. Additional details of these measures can be available at http://hrsonline.isr.umich.edu/sitedocs/userg/dr-006.pdf.