An Equilibrium Analysis of the Long-Term Care Insurance Market

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Abstract

A life-cycle model of intergenerational long-term care decisions is developed to analyze how family interactions affect the equilibrium coverage and welfare in the U.S. long-term care insurance market. In the model, consistent with empirical facts, help provided by adult children substitutes formal long-term care services, and parents' purchase of long-term care insurance discourages children's informal care provision. The model is structurally estimated using data from the Health and Retirement Study by the conditional choice probability (CCP) estimation method. I find that wealthy parents have a disincentive to purchase insurance as it reduces their children's strategic incentive to provide informal care. I also find that the failure to account for heterogeneity in informal care options results in adverse selection where the long-term care insurance market attracts a disproportionate number of individuals with worse informal care options and hence higher expected formal care spending. I demonstrate that using family demographics in pricing long-term care insurance contracts reduces adverse selection and improves the average welfare of the elderly.

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1 Introduction

Elderly individuals face substantial risks of having functional limitations and hence requiring long-term care. In the U.S., about three fourths of 60-year-olds will have chronic conditions resulting in daily activity limitations, while the other fourth will have no such conditions until death. Formal long-term care services are expensive with the median annual cost for nursing homes exceeding $90,000. Public insurance, Medicaid, exists, but is means-tested and one has to be impoverished to be eligible for benefits. Yet, only about 10 percent of the elderly own private long-term care insurance which insures these large formal long-term care expenditure risks. Many researchers have studied why this market is so small, and have identified Medicaid (Brown and Finkelstein, 2008), bequest motives (Lockwood, 2016), private information (Hendren, 2013), market power and administrative costs (Braun, Kopecky, and Koreshkova, 2017) as relevant factors. However, scant attention has been given to the role of unpaid care provided by the family, usually adult children, as a substitute to formal long-term care. In this paper, I develop and structurally estimate an intergenerational game featuring elderly parents' long-term care insurance choice, formal care utilization, and savings, and adult children's informal care provision and labor supply. I embed the estimated intergenerational game within an equilibrium long-term care insurance market to quantify the equilibrium effects of family interactions and explore welfare-increasing policies.

The model incorporates two key mechanisms. First, it incorporates the possibility of adverse selection due to asymmetric information about children's informal care giving. As the provision of long-term care, i.e., assistance with daily tasks, does not require much professional training, informal care provided by adult children substitutes formal care services (Houtven and Norton, 2004; Charles and Sevak, 2005; Houtven and Norton, 2008; Coe, Goda, and Van Houtven, 2015). Even among individuals with public or private long-term care insurance, almost one half rely on informal care from children.[1] As long-term care insurance companies pay only for formal long-term care services, whether a consumer has children who are likely to provide informal care is highly relevant for insurance companies' costs. However, no long-term care insurance company uses information about children in pricing insurance contracts, despite the absence of any regulation. This suggests that insurance companies could attract a disproportionate number of individuals who have worse informal care options and therefore have higher expected formal care spending. To quantify the welfare cost of such adverse selection, I develop a model in which elderly individuals face heterogeneous informal care likelihood from children and make insurance decisions based on that dimension of heterogeneity. In this regard, this paper is related to the vast empirical literature on asymmetric information in insurance markets (see Einav, Finkelstein, and Levin (2010) for a survey of the literature). My contribution lies in identifying the availability of a close substitute, i.e., informal care, as the main source of private information.

[1]Author's calculation using data from the Health and Retirement Study. The sample is restricted to elderly individuals with daily activity limitations who have either Medicaid or private long-term care insurance.

Second, the model incorporates the possibility that children strategically provide informal care to prevent depletion of parent savings on expensive formal care services, and knowing this, elderly parents refrain from purchasing long-term care insurance. This strategic non-purchase of insurance has long been argued by theoretical studies such as Bernheim, Shleifer, and Summers (1985), Pauly (1990), Zweifel and Struwe (1996), and Courbage and Zweifel (2011). Existing reduced-form evidence in the literature also suggests that strategic considerations may be important. For example, Brown (2006) and Groneck (2016) find that parents reward informal caregiving children with a much higher bequest compared to non-caregiving children. By developing and estimating an intergenerational game over long-term care decisions, I provide the first estimate for the effects of strategic interactions of the family on the insurance market equilibrium. This is in contrast to the recent work by Mommaerts (2015) who uses a cooperative model to study long-term care decisions of the family, and analyzes only the demand for long-term care insurance.

Within the dynamic intergenerational game that I develop, an elderly parent and an adult child interact non-cooperatively from the parent's retirement to death.[2] The parent makes a once-and-for-all long-term care insurance purchase decision at retirement, and from then on, experiences health shocks and makes decisions concerning formal care utilization and savings, with Medicaid incorporated as means-tested public long-term care insurance. In this regard, this paper contributes to the literature on elderly savings and medical expenditure uncertainty such as Hubbard, Skinner, and Zeldes (1995), Palumbo (1999), and De Nardi, French, and Jones (2010).

The adult child in each period allocates time to informal care provision, work and leisure over the parent's life-cycle.[3] The child may provide informal care out of altruism or to prevent depletion of her inheritance on formal care. The child's strategic incentive to provide help is diminished if the parent has long-term care insurance, because in that case, insurance companies cover the formal care costs. The parent is forward looking, so if the parent prefers informal care to formal care, she may demand less insurance to avoid diminishing the child's strategic informal care incentive. This is how the model incorporates strategic non-purchase of insurance. Furthermore, the richness of child and parent level heterogeneity results in heterogeneous informal care likelihood across families, allowing for the analysis of insurance selection based on this dimension of private information. Owing to the finite horizon assumption with sequential moves, for a given price of long-term care insurance, the intergenerational game has a unique equilibrium.

I estimate the intergenerational game using the Health and Retirement Study (HRS) 1998-2010 and actual premium data over the sample period. The estimation entails a large computational cost because the model is a dynamic game with many state variables and rich individual heterogeneity. I address the computational challenge by employing a two-stage conditional choice probability (CCP) estimator pioneered by Hotz and Miller (1993) and Hotz, Miller, Sanders, and Smith (1994), and

[2]This feature of the model is related to Barczyk and Kredler (forthcoming) and Fahle (2014) who also estimate a dynamic game of intergenerational care arrangements, but in contrast to this paper, do not incorporate insurance purchase decisions.

[3]Skira (2015) also estimates a dynamic model of an adult child's informal care and work choices, but abstracts away from intergenerational interactions.

further developed in the context of dynamic games by Aguirregabiria and Mira (2007), Bajari, Benkard, and Levin (2007), Pakes, Ostrovsky, and Berry (2007) and Pesendorfer and Schmidt-Dengler (2008). The main idea behind CCP estimators is that it is not necessary to fully solve a dynamic model in order to obtain value functions. Once nonparametric estimates of conditional choice probabilities are obtained in the first stage, one can use these probability estimates to obtain nonparametric estimates of value functions. I use forward simulation to construct value functions in the second stage as in Bajari, Benkard, and Levin (2007).[4] While mostly used in the industrial organization literature, this paper is the first to apply the CCP estimator in estimating a dynamic game of intergenerational decisions. I recover parents' preferences for leaving bequests and receiving informal or formal care, as well as children's preferences for leisure, consumption, and providing informal care. The estimated model is capable of matching the most important features of the data including the monotonically increasing long-term care insurance ownership rate in wealth and the inverted-U pattern of informal care receipt across wealth.

To embed the estimated intergenerational game within an equilibrium long-term care insurance market, I incorporate perfectly competitive risk-neutral insurance companies. The market equilibrium is characterized by the break-even price that leads to zero profits. As the estimated intergenerational game predicts, for a given price of long-term care insurance, the insurance demand and the expected formal care spending which are the main inputs in calculating insurers' profits, I iteratively solve the game until I find the break-even price.

Using the equilibrium insurance market framework, I conduct counterfactuals and obtain the following results. First, there is quantitatively meaningful strategic non-purchase of insurance. When children do not strategically reduce informal care provision in response to parents' purchase of long-term care insurance, the equilibrium ownership rate increases by over 7 percentage points, corresponding to a 63 percent increase. This effect is the greatest among wealthy parents as their children have the strongest strategic incentive to provide care. Second, the failure to account for heterogeneity in informal care options results in adverse selection. Compared to parents who almost always receive informal care in the event of bad health shocks, parents who almost never do demand insurance twice as much and have expected lifetime formal care spending that is higher by almost $100,000. Third, pricing insurance contracts based on family characteristics that highly predict informal care provision from children, such as the presence of a daughter and the number of children, reduces the amounts of private information about informal care options and increases the average welfare of the elderly by almost $5,500.

Finally, as an application of my model, I provide potential reasons for the recent premium increases in the long-term care insurance market. Starting around 2013, which is after the sample period of the estimation data, there have been sharp premium increases not just for new policies but also for existing policies. Rate increases on existing policies were approved by the state gov-

[4] By specifying flow utilities that are linear in structural parameters, the forward simulation procedure is performed only once which greatly reduces the computational cost.

ernments on the basis that policies had been substantially underpriced.[5] My model, which allows rich interactions between insurance demand, formal care utilization, and informal care provision, finds that premiums of typical contracts in 2002 were below the break-even premium by almost 80 percent. The number is consistent with the requested premium increases of 80-85 percent from major long-term care insurance companies on their older blocks of policies. This result serves as external validation of the model. I discuss potential reasons for underpricing and the timing of the premium hikes.

The rest of this paper proceeds as follows. Section 2 presents empirical facts about long-term care in the U.S. Section 3 presents the model. Section 4 presents the data and the estimation results. Section 5 presents the main results. Section 6 concludes.

2 Empirical Facts

I start by providing empirical facts about the U.S. long-term care sector. The main data for this paper come from the Health and Retirement Study (HRS), which surveys a representative sample of Americans over the age of 50 every two years since 1992. Using seven interviews from the HRS 1998-2010, I provide empirical patterns that motivate the model of intergenerational long-term care decisions presented in the next section.

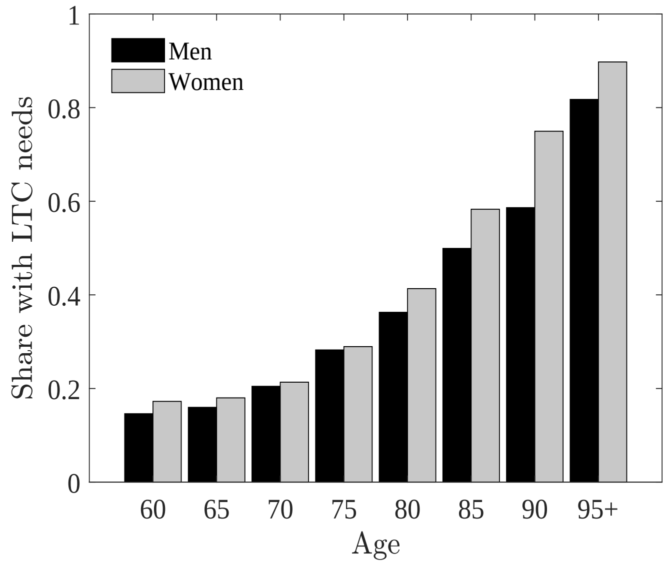
2.1 Background

Substantial long-term care risk. Long-term care is formally defined as assistance with basic personal tasks of everyday life, called Activities of Daily Living (ADLs) or Instrumental Activities of Daily Living (IADLs). Examples of ADLs include bathing, dressing, using the toilet, and getting in and out of bed. IADLs refer to activities that require more skills than ADLs such as doing housework, managing money, using the telephone, and taking medication. Declines in physical or mental abilities are the main reasons for requiring long-term care. Using individuals aged 60 and over in the HRS 1998-2010, Figure 1 reports, for each gender and age group, the share of individuals who have ADL/IADL limitations or are cognitively impaired. Long-term care needs rise sharply with age and over 60 percent of individuals aged 85 and older need assistance with daily tasks. However, not everybody develops ADL/IADL limitations towards the end of their lives. In fact, about 32 percent (19 percent) of healthy 60-year-old men (women) will never need long-term care until their death.[6] These findings suggest that elderly individuals face substantial risks about how much long-term care they would need.

[5]This is in contrast to the existing findings in the literature. Brown and Finkelstein (2007) use an actuarial model of formal long-term care utilization probabilities, and find the average markup of 18 percent for policies sold in 2002.

[6]Author's calculation using the HRS 1998-2010. I provide details about the estimation in Section 4.2.

Figure 1: Long-Term Care (LTC) Needs by Age



Notes: The figure reports the share of respondents who have ADL/IADL limitations or are in the bottom 10 percent of the cognitive score distribution. The sample is limited to individuals aged 60 and over in the HRS 1998-2010.

Informal care as the backbone of long-term care delivery. Unpaid long-term care provided by the family - which I refer to as informal care in this paper - plays a substantial role in the long-term care sector. This is because unlike acute medical care, long-term care does not require professional training; it simply refers to assistance with basic personal tasks. Several studies have documented the importance of informal care in the U.S. long-term care sector. For example, work by Barczyk and Kredler (forthcoming) shows that informal care accounts for 64 percent of all help hours received by the elderly. Using the HRS 1998-2010, I find that 62 percent of individuals with long-term care needs receive some help from children, and among these individuals, almost 80 percent report just one child as the primary caregiver. Table 1 reports how family characteristics vary between individuals who receive informal care from children and those who do not. The number of children, and the presence of a daughter and a child residing in proximity appear to have strong positive correlations with the chance of receiving informal care. Only 4 percent of parents pay their children for help, implying that immediate financial compensation for informal care is rare.

Costly formal care services. Another way to meet one's long-term care needs is to use formal long-term care services, such as nursing homes, assisted living facilities, and paid home care. These formal care services are labor-intensive and expensive. In 2017, the median annual rate was $97,000 for a private room in a nursing home, $45,000 for assisted living facilities, and $48,000 for paid home care.[7] Combined with substantial risks of needing long-term care, formal care is one of the

[7]Source: Genworth.

Table 1: Informal Care Receipt and Family Characteristics

	Sample receiving informal care	Sample not receiving informal care
Average number of children	3.9	2.5
Share who have a daughter	0.86	0.59
Share who have a child within a 10 mile radius	0.84	0.46
Share who pay children for help	0.04	-
Observations	3,464	2,123

Notes: Sample size = 5,587. The sample is limited to single respondents aged 60 and over who have daily activity limitations.

largest financial risks faced by the elderly; 40 percent of 65-year-olds will not have any formal care expenses, while 60 percent will incur on average $100,000 during their remaining life and 5 percent will spend more than $300,000 in 2017 dollars (Kemper, Komisar, and Alecxih, 2005/2006).

A very small long-term care insurance market. Private long-term care insurance provides financial protection against these large formal care risks. The U.S. long-term care insurance market is relatively young and modern insurance products were introduced in the late 1980s.[8] Typical long-term care insurance contracts cover both facility care and paid home care provided by employees of home care agencies. Most do not cover informal care. For underwriting purposes, insurance companies perform cognitive tests, and require medical records, blood and urine samples. No information about applicants' children, who are most likely to be primary informal caregivers, is collected. Premiums are conditional on age, gender, and underwriting class determined by health conditions. Gender-based pricing was newly adopted in 2013, despite the well-known fact that women have a higher chance of using formal care compared to men; the probability of ever using formal care is 40 percent for 65-year-old men, and 54 percent for 65-year-old women (Brown and Finkelstein, 2008). Contracts are guaranteed renewable and specify a constant and nominal annual premium. The average purchase age is 60 years, but most people do not use insurance until they turn 80 (Broker World, 2009-2015). Using the HRS 1998-2010, I find that only 13 percent among individuals aged 60 and over own some form of private long-term care insurance.

Medicaid as the biggest payer for formal care services. Based on a recent report by the Kaiser Family Foundation, formal long-term care expenses totaled over $310 billion in 2013, which is close to 2 percent of GDP.[9] Medicaid is the biggest payer, accounting for 51 percent of the total payments, followed by other public insurance programs (21 percent), out-of-pocket (19 percent), and private long-term care insurance (8 percent). In contrast to a common misconception, Medicare coverage for long-term care is very limited. Only nursing home stays following a qualified hospital stay are covered up to 100 days, and there are substantial copayments for days 21-100. Medicaid, on

[8] Source: National Care Planning Council.

[9] The report can be found at https://www.kff.org/medicaid/report/medicaid-and-long-term-services-and-supports-a-primer/.

the other hand, provides unlimited coverage to eligible individuals with limited assets. While one has to be almost impoverished to be eligible for benefits, individuals can "spend-down" their assets until they meet Medicaid eligibility requirements, which has been identified as an important factor in explaining the limited size of the long-term care insurance market (Brown and Finkelstein, 2008). At $158 billion in 2013, Medicaid spending on long-term care imposes severe fiscal constraints at both state and federal government levels (Commission on Long-Term Care, 2013).

2.2 Private Information in the Long-Term Care Insurance Market

Despite the fact that informal care plays a critical role in delivering long-term care, long-term care insurance companies do not collect any information about children from consumers. This is not because of regulation as there are no restrictions on the characteristics that may be used in pricing long-term care insurance contracts (Brown and Finkelstein, 2007). I now provide evidence that private information about children's informal care provision may be an important source of adverse selection in the long-term care insurance market.

To measure private information about the availability of informal care, I use responses to the following HRS question: "Suppose in the future, you needed help with basic personal care activities like eating or dressing. Will your daughter/son be willing and able to help you over a long period of time?" If beliefs about children's expected informal care provision were an important dimension of private information in the long-term care insurance market, then conditional on information used by insurance companies in setting prices, the responses to this question would be correlated with the formal care risk and the insurance demand in a statistically significant way. To examine if this were true, following the empirical strategy in Finkelstein and McGarry (2006), I estimate the following probit equations:

$$Pr(NH_{i,t\sim t+5} = 1) = \Phi(\alpha_1 B_{it}^{IC} + \beta_1 B_{it}^{NH} + X_{it}\gamma_1) \quad \text{and} \tag{1}$$

$$Pr(LTCI_{it} = 1) = \Phi(\alpha_2 B_{it}^{IC} + \beta_2 B_{it}^{NH} + X_{it}\gamma_2). \tag{2}$$

The term $NH_{i,t\sim t+5}$ is an indicator for staying in a nursing home for more than 100 nights in the next five years since the interview.[10] $LTCI_{it}$ is an indicator for current long-term care insurance holdings. X_{it} is a vector of individual characteristics used by insurance companies for pricing that includes age, gender, and various health conditions.[11] It does not include any information about children as such information is not collected by insurance companies. B_{it}^{IC} is an indicator for whether the individual thinks children will provide informal care. B_{it}^{NH} is the individual's self-assessed probability of entering a nursing home in the next five years. I include this term to compare

[10] Short-term nursing home stays following acute hospitalization are covered by Medicare up to 100 days. To distinguish nursing home stays that are covered by private long-term care insurance from those covered by Medicare, I use nursing home stays lasting more than 100 nights.

[11] I follow Finkelstein and McGarry (2006) and Hendren (2013) to control for pricing covariates.

Table 2: Beliefs about Informal Care, Nursing Home Use, and Insurance Coverage

	(1) Believe children will help	(2) Not believe children will help
Subsequent NH Use	0.014	0.024
LTCI	0.139	0.186
Observations	2,553	2,552

Notes: Column (1) reports the nursing home (NH) utilization rate over the next five years and the current long-term care insurance (LTCI) coverage rate of respondents who believe their children will help with long-term care needs in the future. Column (2) reports the subsequent nursing home utilization and insurance coverage rates of respondents who do not believe their children will help. The sample is limited to individuals aged 70-75 who have children and do not have rejection conditions based on underwriting guidelines in Hendren (2013).

the importance of private information about informal care options (B_{it}^{IC}) to other dimensions of private information, such as unobserved health, that may be captured in B_{it}^{NH}.[12]

To estimate the probit equations, I restrict the sample to individuals who are healthy enough to buy long-term care insurance at the time of interview, and old enough to have long-term care needs over the next five years since the interview. I use individuals aged 70-75 who have children and do not have conditions that render them ineligible to buy long-term care insurance.[13] Table 2 reports the subsequent nursing home utilization rate and the long-term care insurance coverage rate of the sample broken down by whether the respondent believes children will help. About one half of the sample believes children will help. These beliefs appear reasonable because in the data, about 60 percent of respondents with long-term care needs actually receive care from their children. Individuals who believe children will help are less likely to enter a nursing home in the future and to own long-term care insurance.

Table 3 reports the results from the probit estimation. Column (1) shows that individual beliefs about children's informal care provision are powerful predictors of subsequent nursing home use. Individuals who believe their children will help are 1 percentage point less likely to enter a nursing home in the future. This is a substantial effect as 2 percent of the sample use nursing homes in the next five years.[14] What is surprising is that individual beliefs about nursing home entry have no power in predicting subsequent nursing home use; the relationship is indeed negative and statistically insignificant.[15] If beliefs about nursing home entry reflect information about unobserved

[12] Several studies have used self-assessed probability of entering a nursing home, B_{it}^{NH}, to construct a measure of private information about formal care risk (Finkelstein and McGarry, 2006; Hendren, 2013).

[13] I follow Hendren (2013) to identify rejection conditions. I exclude individuals who have ADL/IADL limitations, have experienced a stroke, or have used nursing homes or paid home care in the past.

[14] The negative and significant correlation between beliefs about informal care and subsequent nursing home use holds true when I measure nursing home use over a longer time horizon.

[15] This result is consistent with Hendren (2013) who finds little predictive power of beliefs about nursing home entry among individuals who are eligible to buy long-term care insurance. The fact that beliefs about informal care provision by children have predictive power, while beliefs about nursing home entry do not, suggests individuals' imperfect ability to incorporate all relevant information in forming these beliefs. As

Table 3: Results from the Asymmetric Information Test

	(1) Subsequent NH use		(2) LTCI	
Believe children will help	-0.010**	(0.004)	-0.041***	(0.012)
Subjective prob of future NH use (0-1)	-0.011	(0.012)	0.186***	(0.029)
Female	0.063	(0.157)	0.350	(0.390)
Age	0.004**	(0.002)	0.004	(0.004)
Female*Age	-0.001	(0.002)	-0.005	(0.005)
Psychological condition	0.004	(0.007)	-0.017	(0.024)
Diabetes	0.019***	(0.005)	-0.035*	(0.019)
Lung disease	0.010	(0.007)	-0.059**	(0.025)
Arthritis	-0.008*	(0.004)	-0.000	(0.013)
Heart disease	-0.002	(0.005)	-0.014	(0.017)
Cancer	0.000	(0.006)	-0.017	(0.018)
High blood pressure	0.005	(0.004)	-0.013	(0.014)
Cognitive score (0-1)	-0.106***	(0.020)	0.324***	(0.050)
Observations	5,105		5,105	

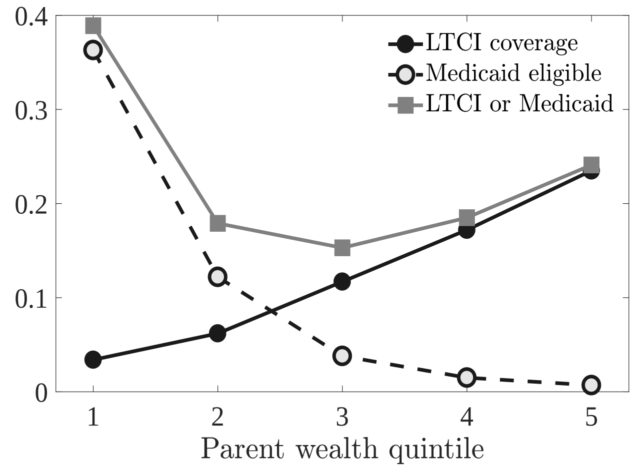
Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Reported coefficients are marginal effects from probit estimation of Equations (1) and (2). Standard errors are clustered at the household level and are reported in parentheses. Dependent variable in Column (1) is an indicator for staying in a nursing home for more than 100 nights in the next five years. Mean is 0.019. Dependent variable in Column (2) is an indicator for long-term care insurance ownership. Mean is 0.163. The sample is limited to individuals aged 70-75 who have children and do not have rejection conditions based on underwriting guidelines in Hendren (2013).

health conditions, the insignificant relationship suggests that the amounts of private information about health are small. Column (2) indicates that there is a negative and significant relationship between beliefs about children's informal care provision and insurance holdings. Individuals who believe their children will help are 4 percentage points less likely to own long-term care insurance. Given the coverage rate of 16 percent among the sample, this finding serves as suggestive evidence that beliefs about children's expected informal care provision have a substantial effect on insurance choices.

Taken together, Table 3 provides suggestive evidence that (1) the dimension of private information that is the most relevant to long-term care insurance companies is individuals' beliefs about children's informal care provision, and (2) individuals with worse informal care options and hence higher expected formal care spending may be more likely to select into insurance, creating potential adverse selection.

argued in Finkelstein and McGarry (2006), if B_{it}^{NH} is a sufficient statistic for private information about nursing home use, then conditional on B_{it}^{NH}, all other individual information (including B_{it}^{IC}) should have no power in predicting nursing home use.

Figure 2: Long-Term Care Insurance Coverage and Medicaid Eligibility by Wealth



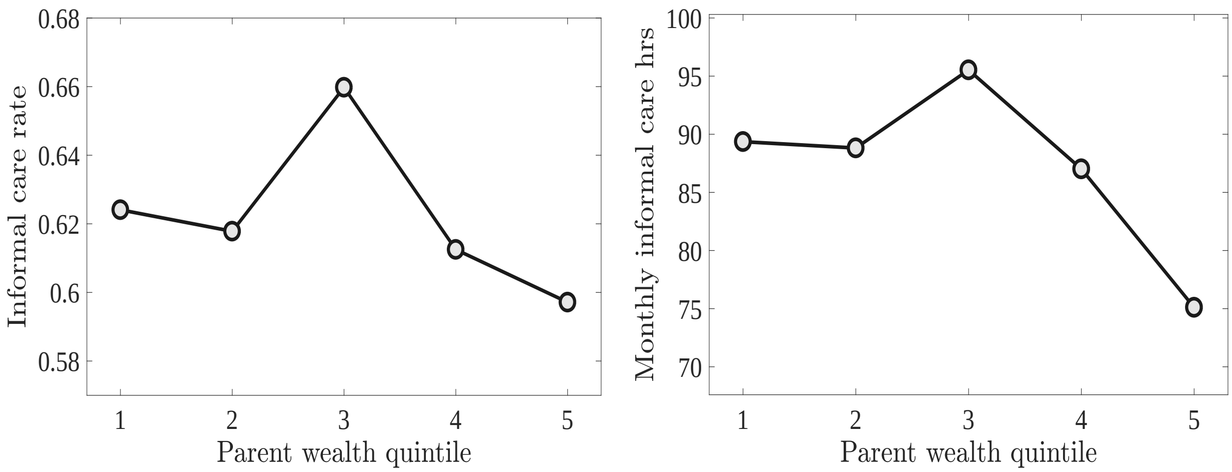
Notes: The black solid line represents the long-term care insurance coverage rate by wealth quintile. The dashed line represents the share of respondents on Medicaid. The gray solid line represents the share of respondents who have either long-term care insurance or Medicaid benefits. The sample is limited to single respondents aged 60 and over in the HRS 1998-2010.

2.3 Strategic Informal Care and Bequests

Several theoretical papers like Bernheim, Shleifer, and Summers (1985), Pauly (1990), Zweifel and Struwe (1996), and Courbage and Zweifel (2011) have long argued that parents may forgo insurance because with insurance, parents cannot use bequests as an effective instrument to elicit favorable behaviors from children (for example, informal care provision). I now provide descriptive statistics that suggest that bequests may play an important role in shaping children's informal care decisions. Given the costly nature of formal care, children may provide care themselves to protect bequests from formal care expenses. If that is the case, the out-of-pocket costs of formal care that parents face may be an important factor in children's informal care decisions. For example, if parents face zero out-of-pocket costs of formal care by having full long-term care insurance or being Medicaid eligible, children will not have any strategic incentive to provide informal care. Based on this intuition, I look for data patterns that suggest a positive relationship between children's informal care provision and parents' out-of-pocket costs of formal care.

Figure 2 reports the long-term care insurance coverage rate (solid line) and the share of Medicaid eligibles (dashed line) by wealth quintile. The long-term care insurance coverage rate increases in wealth while the share of Medicaid eligibles decreases in wealth. Individuals in the middle of the wealth distribution face the largest out-of-pocket costs of formal care as the share covered by either long-term care insurance or Medicaid is the lowest. Indeed, Figure 3 shows that there is an inverted-U pattern of informal care receipt; middle-wealth parents receive the most informal care from children at the extensive and intensive margins. While other factors, such as children's opportunity

Figure 3: Informal Care from Children by Parent Wealth



Notes: The left panel reports the share of respondents receiving care from children by respondent wealth quintile. The right panel reports the average monthly care hours provided by children. The sample is limited to single respondents aged 60 and over who have long-term care needs in the HRS 1998-2010.

costs, may contribute to the inverted-U pattern of informal care, the positive relationship between children's informal care provision and parents' out-of-pocket costs of formal care suggest that children may provide informal care to protect bequests from formal care expenses. In Appendix A, I present further descriptive evidence that long-term care insurance undermines children's informal care incentives.

Several empirical studies also find a significant relationship between bequests and children's informal care behaviors. Brown (2006) uses inclusion in life insurance policies and wills as proxies for bequests and finds that caregiving children are more likely to receive end-of-life transfers from parents. Groneck (2016) uses actual bequest data obtained from the HRS exit interviews and finds that caregiving children, on average, receive bequest amounts that are twice as much as those received by non-caregiving children. These findings provide further support for strategically-motivated informal care and bequests.

3 Intergenerational Game

This section presents the model that I develop to derive the demand for long-term care insurance, which incorporates the possibility that (1) elderly parents make long-term care insurance purchase decisions with beliefs over children's informal care decisions, and (2) children provide informal care in part to prevent depletion of parental savings on formal care costs. For now, I abstract away from the supply side of the long-term care insurance market and assume standard long term care insurance policies are sold at a given price. I explicitly introduce the supply side and define the insurance market equilibrium in Section 5 where I present counterfactuals.

The model presented in this section describes interactions between an elderly parent and an adult child from the parent's retirement to death.[16] To incorporate strategic concerns, the model assumes the parent and the child interact non-cooperatively, each making decisions to maximize his or her own expected utility with beliefs over the other player's actions. In each period, the child makes a labor force participation decision, and when the parent experiences a bad health shock, the child makes an informal care supply decision. As the child inherits the parent's wealth, the child may provide informal care to protect parental savings from formal care expenses. The parent makes a once-and-for-all long-term care insurance purchase decision at retirement, and from then on, experiences health shocks, and makes decisions concerning formal care utilization, and savings. As the parent does not use formal care while receiving informal care, the parent's demand for long-term care insurance depends on her beliefs about the child's informal care decisions. The model incorporates Medicaid as means-tested public long-term care insurance, and rich parent and child level heterogeneity.

3.1 Environment

Time, indexed by t, is discrete and finite. Variables related to the parent will have superscript P, and variables related to the child will have superscript K. This is a model of one parent and one child, so I omit i subscripts. Let age_t^P and age_t^K denote the parent's and the child's age in period t, respectively. In the first period, the parent is 60 years old, i.e., $age_1^P = 60$. The model incorporates uncertainties about the parent's and the child's preference shocks, and the parent's health and wealth shocks. The parent's health status, denoted by h_t^P, can take four values; the parent can be healthy ($h_t^P = 0$), have light long-term care needs ($h_t^P = 1$), have severe long-term care needs ($h_t^P = 2$), or be dead ($h_t^P = 3$).

At the beginning of each period, the parent's health and wealth shocks are realized, and are commonly observed by the parent and the child. If the parent is alive, then the child privately observes the realization of her preference shocks, and moves first by choosing the discrete vector $d_t^K = (ic_t^K, e_t^K)$ comprising hours of informal care ic_t^K and labor force participation e_t^K. The child's flow utility while the parent is alive is represented as:

$$\pi^K(c_t^K, l_t^K, ic_t^K; h_t^P, ic_{t-1}^K, X^K) + \epsilon_t^K(d_t^K) \tag{3}$$

[16] I focus on interactions between one parent and one child because most parents receive informal care from just one child (as discussed in Section 2), and incorporating informal care decisions by spouse and multiple children would result in a substantial computational cost. While the model does not endogenize informal care decisions of multiple children, it incorporates the possibility that the number of children affects the chance of using formal care services in a reduced-form way. Details will be presented in Section 3.1.

where

$$c_t^K = y^K(e_t^K; e_{t-1}^K, age_t^K, X^K), \tag{4}$$

$$l_t^K = T_{total} - ic_t^K - T_{e_t^K}. \tag{5}$$

The child derives utility from consumption c_t^K, leisure l_t^K, informal care provision ic_t^K, and additive preference shock associated with discrete choice vector d_t^K, denoted by $\epsilon_t^K(d_t^K)$. Appendix B presents the exact specification of utility function π^K; it is additively separable in preferences for consumption, leisure, and informal care hours, and the consumption and leisure preferences follow a constant relative risk aversion utility function. The assumption that informal care hours directly enter the child's utility function implies that the child may be impurely altruistic toward the parent, and may derive utility from the act of providing informal care. This warm-glow utility may also depend on the parent's health status h_t^P, the child's informal care provision in the previous period ic_{t-1}^K, and the child's demographic characteristics X^K. The possible dependence upon ic_{t-1}^K is to incorporate costs associated with initiating informal care provision. Equation (4) states that the child's consumption is equal to her income which is determined by her labor force participation choice, past employment, age, and demographic characteristics. Appendix B presents the exact specification of income function y^K. The child's leisure time is residually determined by the time constraint in Equation (5) where T_{total} is the child's total endowed time and $T_{e_t^K}$ represents the required hours for work choice e_t^K. I assume the preference shock ϵ_t^K follows an *i.i.d.* extreme value type I distribution with scale one.

In each period, the parent moves after observing the child's choices. This timing assumption is imposed to avoid the issue of multiple equilibria in a simultaneous-move version of the game. While the parent is alive, in each period, the parent makes decisions regarding formal care utilization and consumption. The parent's formal care utilization choice is discrete, and she can use paid home care, enter a nursing home, or not use any formal care. The parent never uses formal care when she is healthy or the child provides informal care. This assumption implies that informal and formal care are substitutes, as found in empirical studies like Charles and Sevak (2005) and Coe, Goda, and Van Houtven (2015). In the first period, the parent is assumed to be healthy (so the parent does not use any formal care), and she chooses whether to buy long-term care insurance once-and-for-all. I consider one standardized long-term care insurance policy with the following features. It covers both paid home care and nursing homes, pays benefits for formal care expenses only when the parent is unhealthy, has a maximal per-period benefit cap, and provides coverage for life.[17] The per-period premium is $p(X^P, X^K)$, implying that I allow the premium to vary by the parent and the child's demographic characteristics, X^P and X^K, respectively. The premium is paid in every period when the parent is not receiving benefits from the insurance company.

[17]These features are based on typical long-term care insurance products sold during my sample period (Brown and Finkelstein, 2007; Broker World, 2009-2015).

The parent's flow utility when the parent is alive is represented as

$$\pi^P(c_t^P, fc_t^P, ic_t^K; h_t^P, n^P) + \epsilon_t^P(d_t^P). \tag{6}$$

The parent derives utility from consumption c_t^P, formal care fc_t^P, informal care hours chosen and provided by the child ic_t^K, and additive preference shock associated with discrete choice d_t^P, denoted by $\epsilon_t^P(d_t^P)$.[18] The discrete choice d_t^P represents the insurance choice in the first period, and formal care choice for all other periods. Appendix B presents the exact specification for utility function π^P; it is additively separable in preferences for consumption, formal care, and informal care, and the consumption preference follows a constant relative risk aversion utility function. The assumption that fc_t^P and ic_t^K directly enter the parent's utility function implies that the parent has a preference over formal and informal care, which may depend on the parent's health status. The parent's preference for formal care may also depend on the parent's number of children, denoted by n^P. This assumption is to capture the effect of having multiple children on formal care expenditure risk in a reduced-form way. I assume the preference shock ϵ_t^P is privately observed by the parent before she makes the discrete choice, and follows an *i.i.d.* extreme value type I distribution with scale one.

I now describe preferences when the parent dies. The model closes when the parent's health status is realized to be death, and the parent dies for sure at age 100. The parent leaves her remaining wealth w_t^P to the family and derives the following bequest utility:

$$\pi_d^P(w_t^P) = \theta_d^P w_t^P. \tag{7}$$

This linear functional form follows Hurd (1989), Kopczuk and Lupton (2007), and Lockwood (2016), and implies that bequests are luxury goods and the parent is less risk-averse over bequests than over consumption. The child inherits a share of the parent's wealth, and this is how the model incorporates the child's strategic incentive. As the parent does not incur any formal care expenses while receiving informal care from the child, the child may be strategically motivated to provide informal care in order to preserve the parent's savings. The child's terminal value is represented as the following:

$$\pi_d^K(w_t^P, X^K) \tag{8}$$

which depends on the parent's bequest and the child's demographic characteristics. The exact specification for π_d^K is found in Appendix B.

State variables and transition. The set of state variables that are commonly observed by the parent and the child at the beginning of period t, after the resolution of uncertainty about the

[18] The parent's flow utility is not a function of leisure because I assume that (1) the parent spends all her time on leisure, and (2) her leisure utility is additively separable.

parent's health and wealth is:

$$s_t = (age_t^P, h_t^P, w_t^P, ltci_t^P, age_t^K, ic_{t-1}^K, e_{t-1}^K; X^P, X^K).$$

w_t^P is the parent's wealth after the wealth shock, and $ltci_t^P$ is an indicator that is equal to one if the parent has long-term care insurance, and zero otherwise. The value of $ltci_t^P$ is determined in the first period as a result of the parent's long-term care insurance decision. X^P is the set of the parent's demographic characteristics including gender, permanent income, and number of children, and X^K represents the child's demographic characteristics including gender, education, marital status, home ownership, and residential proximity to the parent.

All variables in s_t evolve deterministically except for the parent's health and wealth. The parent's health transition probabilities follow a Markov chain and depend on the parent's gender, age, and current health status.[19] To specify the parent's wealth accumulation law, I first describe how the model incorporates Medicaid. To be Medicaid eligible, the parent's net resources after paying the out-of-pocket cost of formal care must be less than the Medicaid threshold:

$$w_t^P + y^P - \left(x_{fc_t^P, h_t^P} - \min\{b, x_{fc_t^P, h_t^P}\}\right) \quad \leq \quad \bar{w}_{fc_t^P} \tag{9}$$

where y^P is the parent's permanent income, $x_{fc_t^P, h_t^P}$ is the price of formal care choice fc_t^P in health status h_t^P, b is the per-period benefit from long-term care insurance (zero if the parent is not an insurance owner), and $\bar{w}_{fc_t^P}$ is the Medicaid threshold which depends on the parent's formal care choice.[20] If the parent is Medicaid eligible, then her out-of-pocket cost of formal care is reduced to $\max\{0, w_t^P + y^P - \bar{w}_{fc_t^P}\}$ and Medicaid pays the remaining cost:

$$x_{fc_t^P, h_t^P} - \min\{b, x_{fc_t^P, h_t^P}\} - \max\{0, w_t^P + y^P - \bar{w}_{fc_t^P}\}.$$

Note that (1) Medicaid is a secondary payer in the sense that long-term care insurance must pay the benefits first, and (2) the parent becomes Medicaid eligible only after having spent down her net resources to the Medicaid threshold. The parent's wealth after paying the long-term care insurance premium and the out-of-pocket cost of formal care, if any, is

$$\tilde{w}_t^P = \begin{cases} w_t^P + y^P - \max\{0, w_t^P + y^P - \bar{w}_{fc_t^P}\} = \min\{w_t^P + y^P, \bar{w}_{fc_t^P}\} & \text{if Medicaid eligible,} \\ w_t^P + y^P - \left(x_{fc_t^P, h_t^P} - \min\{b, x_{fc_t^P, h_t^P}\}\right) - p(X^P, X^K) & \text{otherwise.} \end{cases} \tag{10}$$

If the parent does not own any long-term care insurance, then $b = p(X^P, X^K) = 0$. To make sure that the parent maintains strictly positive consumption, there is a government transfer up to $g_{fc_t^P}$,

[19] This suggests that the parent's health transition process is exogenous and does not depend on the receipt of informal or formal care. This is based on previous studies that find that the evolution of long-term care needs is largely unaffected by the use of long-term care (Byrne, Goeree, Hiedemann, and Stern, 2009).

[20] The Medicaid resource threshold for paid home care is substantially higher than that for nursing home care. The modal income threshold for paid home care was $545 per month, while it was only $30 per month for nursing homes in 1999 (Brown and Finkelstein, 2008).

which depends on the parent's formal care choice. This can be thought of as the Supplemental Security Income (SSI) benefits, which vary by beneficiaries' nursing home residency. The parent's wealth after this government transfer is

$$\hat{w}_t^P(s_t, d_t^P) := \max\{\tilde{w}_t^P, g_{fc_t^P}\}. \tag{11}$$

There is no borrowing and the parent's consumption is constrained by $c_t^P \leq \hat{w}_t^P(s_t, d_t^P)$. The parent's wealth at the beginning of the next period is given by

$$w_{t+1}^P = \max\left\{0, (1+r)\left(\hat{w}_t^P(s_t, d_t^P) - c_t^P\right) - m_{t+1}^P\right\} \tag{12}$$

where r is the real per-period interest rate, and m_{t+1}^P is the *i.i.d.* wealth shock realized at the beginning of the next period for which the parent is liable up to $\hat{w}_t^P(s_t, d_t^P) - c_t^P$.

3.2 Equilibrium of the Intergenerational Game

To define equilibrium decision rules of the family, I first formally define a strategy profile $\sigma = (\sigma^K, \sigma^P)$ comprising a set of decision rules for the child σ^K and a set of decision rules for the parent σ^P. σ^K specifies the child's informal care supply and labor force participation decision rules over the parent's life-cycle. Specifically, $\sigma^K = \{\sigma^K(s_t, \epsilon_t^K)\}$ is a mapping from the common state space, S, and the space of the child's private preference shocks, $R^{|\mathbb{C}^K|}$, to the set of the child's informal care and labor force participation choices, $\mathbb{C}^K$:

$$\sigma^K : S \times R^{|\mathbb{C}^K|} \to \mathbb{C}^K.$$

$\sigma^P = (\sigma^{P,d}, \sigma^{P,c})$ is composed of the parent's discrete choice decision rules $\sigma^{P,d}$ and consumption decision rules $\sigma^{P,c}$ over the parent's life-cycle. In the first period, the discrete choice is the once-and-for-all long-term care insurance purchase choice, and for all other periods, it is the formal care utilization choice. As the parent makes the discrete choice after observing the child's choice, $\sigma^{P,d} = \{\sigma^{P,d}(s_t, d_t^K, \epsilon_t^P)\}$ is a mapping from the common state space, the child's choice set, and the space of the parent's private preference shocks, $R^{|\mathbb{C}^P|}$, to the parent's discrete choice set, $\mathbb{C}^P$:

$$\sigma^{P,d} : S \times \mathbb{C}^K \times R^{|\mathbb{C}^P|} \to \mathbb{C}^P.$$

The parent chooses consumption after her discrete choice. So $\sigma^{P,c} = \{\sigma^{P,c}(s_t, d_t^K, d_t^P)\}$ is a mapping from the common state space, the child's choice set, and the parent's set of discrete choices to the strictly positive real line:[21]

$$\sigma^{P,c} : S \times \mathbb{C}^K \times \mathbb{C}^P \to R_+.$$

[21] As the parent's preference shocks (ϵ_t^P) are additively separable and serially independent, conditional on the parent's discrete choices, these shocks are irrelevant to consumption choices.

Let $\tilde{V}^K(s_t, \epsilon_t^K; \sigma)$ denote the child's value in the state s_t after the realization of her private preference shocks ϵ_t^K if she behaves optimally today and in the future when the parent behaves according to her decision rules specified in σ. In states where the parent is dead, with a slight abuse of notation, define $\tilde{V}^K = \pi_d^K$ where π_d^K is the child's terminal value as defined in Equation (8). In each period while the parent is alive, the child solves the following problem:

$$\tilde{V}^K(s_t, \epsilon_t^K; \sigma) = \max_{d_t^K \in \mathbb{C}^K(s_t)} \left\{ \pi^K + \epsilon_t^K(d_t^K) + \beta E\left[\tilde{V}^K(s_{t+1}, \epsilon_{t+1}^K; \sigma) \Big| s_t, d_t^K; \sigma \right] \right\} \tag{13}$$

where π^K is defined as in Equation (3) but all arguments are suppressed for notational simplicity, β is the discount factor, and the expectation is over the parent's private preference shocks of the current period, the parent's health and wealth shocks of the next period, and the child's private preference shocks of the next period. $\mathbb{C}^K(s_t)$ denotes the set of the child's feasible informal care and labor force participation choices in state s_t. Define $V^K(s_t; \sigma)$ as the expected value function, $V^K(s_t; \sigma) = \int \tilde{V}^K(s_t, \epsilon_t^K; \sigma) g(\epsilon_t^K)$ where g is the probability density function of ϵ_t^K. Define the choice-specific value function, $v^K(s_t, d_t^K; \sigma)$, as the per-period payoff of choosing d_t^K minus the preference shock plus the expected value function:

$$v^K(s_t, d_t^K; \sigma) = \pi^K + \beta E\Big[V^K(s_{t+1}; \sigma)\Big| s_t, d_t^K; \sigma\Big] \tag{14}$$

where again, π^K is defined as in Equation (3).

I similarly define value functions for the parent. Let $\tilde{V}^P(s_t, d_t^K, \epsilon_t^P; \sigma)$ denote the parent's value if the parent behaves optimally today and in the future when the child behaves according to her decision rules specified in σ. Again, with a slight abuse of notation, define $\tilde{V}^P = \pi_d^P$ in states where the parent is dead, where π_d^P is the parent's bequest utility as defined in Equation (7). The parent's problem when she is alive can be written as

$$\begin{aligned} \tilde{V}^P(s_t, d_t^K, \epsilon_t^P; \sigma) = \max_{d_t^P \in \mathbb{C}^P(s_t, d_t^K), c_t^P \in (0, \hat{w}_t^P(s_t, d_t^P)]} & \Big\{ \pi^P(c_t^P) + \epsilon_t^P(d_t^P) \\ & + \beta E\left[\tilde{V}^P(s_{t+1}, d_{t+1}^K, \epsilon_{t+1}^P; \sigma) \Big| s_t, d_t^K, d_t^P, c_t^P; \sigma \right] \Big\} \end{aligned} \tag{15}$$

where $\pi^P(c_t^P)$ is defined as in Equation (6) but arguments other than c_t^P are suppressed for notational simplicity, the expectation is over the parent's wealth, health, and preference shocks of the next period, and the child's private preference shocks of the next period. $\mathbb{C}^P(s_t, d_t^K)$ denotes the set of the parent's feasible discrete choices in state s_t when the child's choice is d_t^K.[22] As there is no borrowing, consumption cannot be greater than the wealth after the government transfer, $\hat{w}_t^P(s_t, d_t^P)$ as defined in Equation (11). I define the parent's expected value function as $V^P(s_t, d^K; \sigma) = \int \tilde{V}^P(s_t, d_t^K, \epsilon_t^P; \sigma) g(\epsilon_t^P)$. I denote the parent's choice-specific value function as $v^P(s_t, d_t^K, d_t^P; \sigma)$, and it is defined as the parent's per-period payoff of choosing discrete choice d_t^P

[22]The dependence upon d_t^K is because of the assumption that the parent does not use formal care when the child provides informal care.

minus the preference shock plus her expected value function,

$$v^P(s_t, d_t^K, d_t^P; \sigma) = \pi^P(\sigma^{P,c}(s_t, d_t^K, d_t^P)) + \beta E\Big[V^P(s_{t+1}, d_{t+1}^K; \sigma)\Big| s_t, d_t^K, d_t^P, \sigma^{P,c}(s_t, d_t^K, d_t^P); \sigma\Big] \tag{16}$$

where I replaced c_t^P by $\sigma^{P,c}(s_t, d_t^K, d_t^P)$, the implied consumption contained in σ.

Definition. A strategy profile $\sigma^* = (\sigma^{K,*}, \sigma^{P,*})$ is a Markov perfect equilibrium (MPE) of the intergenerational game if for any $(s_t, \epsilon_t^K) \in S \times R^{|\mathbb{C}^K|}$,

$$\sigma^{K,*}(s_t, \epsilon_t^K) = \underset{d_t^K \in \mathbb{C}^K(s_t)}{\operatorname{argmax}} \left\{ v^K(s_t, d_t^K; \sigma^*) + \epsilon_t^K(d_t^K) \right\}, \tag{17}$$

for any $(s_t, d_t^K, \epsilon_t^P) \in S \times \mathbb{C}^K \times R^{|\mathbb{C}^P|}$,

$$\sigma^{P,d,*}(s_t, d_t^K, \epsilon_t^P) = \underset{d_t^P \in \mathbb{C}^P(s_t, d_t^K)}{\operatorname{argmax}} \left\{ v^P(s_t, d_t^K, d_t^P; \sigma^*) + \epsilon_t^P(d_t^P) \right\}, \tag{18}$$

and for any $(s_t, d_t^K, d_t^P) \in S \times \mathbb{C}^K \times \mathbb{C}^P$,

$$\sigma^{P,c,*}(s_t, d_t^K, d_t^P) = \underset{c_t^P \in (0, \hat{w}_t^P(s_t, d_t^P)]}{\operatorname{argmax}} \left\{ \pi^P(c_t^P) + \beta E\Big[V^P(s_{t+1}, d_{t+1}^K; \sigma^*)\Big| s_t, d_t^K, d_t^P, c_t^P; \sigma^*\Big] \right\}. \tag{19}$$

As the model is finite, and within each period, there are sequential moves by the players (the child moves first followed by the parent), the model has a unique equilibrium.

3.3 Solution Method

As the preference shocks, ϵ_t^K and ϵ_t^P, are unobserved by the econometrician, I define a set of conditional choice probabilities (CCP) corresponding to discrete choice rules σ^K and $\sigma^{P,d}$ as

$$P^{K,\sigma}(d_t^K | s_t) = \int \mathbb{I}\left\{ \sigma^K(s_t, \epsilon_t^K) = d_t^K \right\} g(\epsilon_t^K) \quad \text{and} \tag{20}$$

$$P^{P,\sigma}(d_t^P | s_t, d_t^K) = \int \mathbb{I}\left\{ \sigma^{P,d}(s_t, d_t^K, \epsilon_t^P) = d_t^P \right\} g(\epsilon_t^P), \tag{21}$$

respectively, and define $P^\sigma := (P^{K,\sigma}, P^{P,\sigma}, \sigma^{P,c})$. Compared to σ, P^σ represents the *expected* or *ex-ante* discrete choices of the child and the parent while they both specify the parent's consumption decision rules in the same manner. As the value functions in Equations (17), (18), and (19) only depend on σ through P^σ, rather than solving for a MPE σ^*, I solve for $P^* := P^{\sigma^*}$ instead. I discretize the parent's wealth into a fine grid and use linear interpolation for wealth points not contained in the grid. As the wealth shocks are assumed to be normally distributed, I use Gauss-Hermite quadrature to numerically integrate over the wealth shocks. I start with the terminal period when the parent is 100 years old and dies for sure. The terminal values for the child and the parent are given as $V^K = \pi_d^K$ and $V^P = \pi_d^P$, respectively. I proceed backward in time, and apply the following steps:

(1) I obtain the parent's optimal consumption by solving Equation (19).

(2) I obtain the parent's optimal CCP by solving Equation (18) and integrating out ϵ_t^P. As ϵ_t^P is *i.i.d.* and follows an extreme value type I distribution with scale one, I obtain a closed-form expression for $P^{P,*}$:

$$P^{P,*}(d_t^P|s_t, d_t^K) = \frac{\exp\left(v^P(s_t, d_t^K, d_t^P; P^*)\right)}{\sum_{d_t^P \in \mathbb{C}^P(s_t, d_t^K)} \exp\left(v^P(s_t, d_t^K, d_t^P; P^*)\right)}. \tag{22}$$

(3) I obtain the child's optimal CCP by solving Equation (17) and integrating out ϵ_t^K. As ϵ_t^K is *i.i.d.* and follows an extreme value type I distribution with scale one, I obtain a closed-form expression for $P^{K,*}$:

$$P^{K,*}(d_t^K|s_t) = \frac{\exp\left(v^K(s_t, d_t^K; P^*)\right)}{\sum_{d_t^K \in \mathbb{C}^K(s_t)} \exp\left(v^K(s_t, d_t^K; P^*)\right)}. \tag{23}$$

4 Estimation of the Intergenerational Game

I structurally estimate the preference parameters of the parent and the child.[23] This section presents the estimation data, the CCP estimator, identification, and estimation results. All monetary values presented henceforth are in 2013 dollars unless otherwise stated.

4.1 Data

The HRS is a panel survey of a representative sample of the U.S. population over the age 50, and it surveys more than 20,000 Americans every two years. Among other things, the HRS provides information about respondents' assets, long-term care insurance holdings, formal care utilization, and their degree of long-term care needs measured by the number of ADL/IADL limitations and cognitive impairment. It also asks respondents whether and how much (measured in monthly hours) they receive informal care from their children.

For the estimation, I use seven interviews from the HRS 1998-2010, and I restrict the sample to single respondents aged 60 and over in 1998 who have children, and do not miss any interviews as long as they are alive. As the model describes informal care decisions of one adult child, I

[23] The exact set of estimated parameters is listed in Tables 7 and 8, and their notations are introduced in Appendix B.

apply the following rules to match one child to each respondent with multiple children.[24] For respondents who ever receive informal care from children, I pick the primary caregiving child based on the intensity of informal care provided over the sample period.[25] For respondents who do not receive any informal care from children over the sample period, I randomly select one child.[26] The estimation sample consists of 4,183 families and 19,292 family-year observations.

The HRS does not ask respondents about their consumption behaviors, but a subsample of the HRS respondents were selected at random and surveyed about their consumption behaviors biennially from 2003 to 2013 in the Consumption and Activities Mail Survey (CAMS). About 25 percent of my HRS sample is found in the CAMS data. Using information about respondents' assets, income, age, health, and education as well as their children's demographics, I impute consumption for the remaining sample.

For parent health, I use information about ADL limitations and cognitive impairment. The survey asks respondents whether they have a difficulty carrying out each of the five ADLs (bathing, dressing, eating, getting in/out of bed and walking across a room), and conducts various tests designed to measure cognitive ability (for example, word recall, subtraction, backward number counting, object naming, date naming, and president naming). I classify a respondent as healthy ($h_t^P = 0$) if she is not cognitively impaired and has zero or one ADL limitation, as having light long-term care needs ($h_t^P = 1$) if she is not cognitively impaired but has two or three ADL limitations, and as having severe long-term care needs ($h_t^P = 2$) if she is cognitively impaired or has four or more ADL limitations.[27]

I measure parent wealth as the net value of total assets less debts, which includes real estate, housing, vehicles, businesses, stocks, bonds, checking and savings accounts, and other assets. For the parent's permanent income, I use the sum of capital income, employer pension, annuity income, social security retirement income, and other income. As the model assumes the parent's income is time-invariant, for each parent in the sample, I compute the average income over the sample period.

To obtain data on long-term care insurance choices, I use respondents aged 60-69 who were healthy enough to purchase insurance in 1998. Out of 4,183 parents in the estimation sample, 1,053 parents fall into this subgroup. A respondent from this subgroup is categorized as a long-term care insurance buyer if she reports having a private long-term care insurance policy for almost

[24]While the model endogenizes the informal care choices of one child, it still incorporates the possibility of multiple children providing care by allowing the parent's formal care preferences to depend on the number of children.

[25]I sequentially use the following measures of informal care intensity until ties are broken. First, I use the number of interviews in which the child is reported to help. Second, I use the number of total help hours over the sample period. Third, I use the number of total help days. For the very few observations left with ties (only about 2 percent), I randomly select one child.

[26]I do not select children based on their characteristics (e.g., gender) because I am interested in identifying characteristics that predict informal care provision.

[27]I categorize a respondent as cognitively impaired if she is in the bottom 10 percent of the cognitive score distribution.

Table 4: Parent Estimation Sample

	Mean	Median
Female	0.79	
Age	78	
Have 4+ children	0.40	
Wealth ($)	203,651	88,000
Annual income ($)	21,576	17,448
Annual consumption ($)	37,779	34,374
Buy LTCI	0.14	
Have LTC needs	0.38	
Receive informal care	0.45	
Use paid home care	0.37	
Use nursing homes	0.26	

Notes: The estimation sample consists of 4,183 families and 19,292 family-year observations. Monetary values are in 2013 dollars. Long-term care needs are defined based on ADL limitations and cognitive impairments (see the text for details). The insurance purchase rate is among respondents who were healthy and aged 60-69 in 1998. The informal care receipt rate is among respondents who have long-term care needs. The formal care utilization rates are among respondents who have long-term care needs and do not receive informal care.

half of the interview waves. About 14 percent of the 1,053 parents are classified as long-term care insurance buyers.

A parent is categorized as a nursing home user if she reports having spent more than 100 nights in a nursing home in the last two years and a paid home care user if she reports having used home health aides in the last two years.[28] For very few parents who report having used both nursing home and paid home care, I assume they are nursing home users.[29]

The model does not allow for the simultaneous use of formal and informal care.[30] If a parent in the sample reports having used both formal and informal care, then I apply the following rules to determine the type of care. If the parent has used paid home care and received informal care, then I assume the type of care is informal care. If the parent has used nursing home care and received informal care, then I assume the type of care is informal care for the parent with light long-term care needs, and nursing home care for the parent with severe long-term care needs.

Table 4 presents the summary statistics for the parent sample. About 80 percent of the parents are female. The mean wealth is $203,651 and the mean annual income is $21,576. The average number of children is around three, and 40 percent have four or more children. Among respondents who were aged 60-69 in 1998, 14 percent purchased long-term care insurance. Almost 40 percent of the parents have long-term care needs; 45 percent of these disabled parents receive care from their children. Among respondents who have long-term care needs and do not receive care from children, 37 percent use paid home care and 26 percent use nursing homes. Table 5 presents the

[28] The HRS does not ask about the intensity of paid home care utilization.

[29] This is very rare as the question about paid home care use is largely skipped for nursing home residents.

[30] In the sample, only about 20 percent of the parents receiving informal care use formal care services.

Table 5: Child Estimation Sample

	(1) All	(2) Never caregivers	(3) Caregivers
Female	0.56	0.48	0.67
Age	47.32	45.74	49.54
Have some college education	0.45	0.47	0.42
Married	0.67	0.69	0.64
Live within 10 mi of the parent	0.54	0.39	0.74
Homeowner	0.62	0.64	0.60
Work full-time	0.68	0.73	0.62
Ever paid to help			0.05
Observations	4,183	2,438	1,745

Notes: The estimation sample consists of 4,183 families and 19,292 family-year observations. Column (1) reports summary statistics of all children in the sample. Column (2) reports summary statistics of children who never provide informal care over the sample period. Column (3) reports summary statistics of children who provide some informal care over the sample period.

summary statistics for the child sample. Compared to children who never provide care over the sample period, caregiving children are more likely to be female and live closer to parents. They are less likely to have a college education and work full-time.

4.2 Empirical Specification

As the HRS interviews are conducted biennially, a period in the model corresponds to two years. I use the common discount factor of $\beta = \frac{1}{1.06}$, corresponding to a 3 percent time preference rate per year (Brown and Finkelstein, 2008). I assume a coefficient of relative risk aversion of 1 for the child's consumption and leisure utility functions (i.e., log functions). This choice follows Skira (2015) who also studies an adult child's informal care decisions in a dynamic framework. I assume a coefficient of relative risk aversion of 3 for the parent's consumption utility function following Brown and Finkelstein (2008) who study an elderly individual's long-term care insurance choice in a life-cycle framework.

The model assumes the parent's health transition probabilities follow an exogenously given Markov process, where the next period's health is determined by the parent's gender, age, and current health. I estimate these health transition probabilities by maximum likelihood estimation using a logit that is a flexible function of health, age, and gender. Table 6 reports the probabilities of different health statuses for a healthy 60-year-old at different subsequent ages. A 60-year-old man has a 68 percent chance of ever experiencing long-term care needs, while a 60-year-old woman has an 81 percent chance. These estimates are consistent with previous findings in the literature (Kemper, Komisar, and Alecxih, 2005/2006).

The parental wealth shock is assumed to follow an exogenously given normal distribution. I estimate the normal mean and variance outside the model using the wealth accumulation law of

Table 6: Health Probabilities for a 60-year-old at Subsequent Ages

	Age 68	Age 78	Age 88	Age 98	
Male:					
Healthy	0.7305	0.4014	0.0966	0.0026	
Light LTC needs	0.0601	0.0632	0.0320	0.0021	
Severe LTC needs	0.0462	0.0746	0.0536	0.0050	
Dead	0.1631	0.4608	0.8179	0.9902	
Ever have LTC needs					0.6756
Female:					
Healthy	0.7607	0.4786	0.1304	0.0031	
Light LTC needs	0.0820	0.0940	0.0575	0.0044	
Severe LTC needs	0.0591	0.1044	0.1113	0.0203	
Dead	0.0982	0.3230	0.7007	0.9722	
Ever have LTC needs					0.8149

Notes: The table reports probabilities of different health statuses for a healthy 60-year-old at different subsequent ages. The health transition probabilities take the logistic functional forms and are estimated using maximum likelihood estimation.

the model. The estimated mean is $10,805 and the standard deviation is about four times the mean. As mentioned in Section 3.1, I assume the parent's and the child's preference shocks follow an *i.i.d.* extreme value type I distribution with scale one.

In the model, there is one standard long-term care insurance policy that the healthy parent can purchase at age 60. Based on the data collected by Broker World in their survey of major long-term care insurance companies, I assume the standard policy has a per-period benefit cap that is equivalent to 70 percent of nursing home costs, and provides coverage for life.[31] During the sample period of 1998-2010, premiums varied only by age and health, so all healthy 60-year-olds paid the same price regardless of their other demographics, i.e, $p(X^P, X^K) = p$. From Brown and Finkelstein (2007), I obtain the average premium which is about $6,390 per period ($3,195 per year).[32] In estimating the model, I assume this is the per-period premium that all parents uniformly pay if they purchase insurance at age 60.

For the purpose of modeling informal care choices, I assume there are three values of informal care hours that the child can choose from in each period; zero hours, 2,190 hours (21 hours per week), and 4,390 hours (42 hours per week). I assume labor market employment requires 4,390 hours (42 hours per week). The child's total endowed time is set at 11,680 hours per period (112 hours per week).

To set the formal care prices, I use the average rates in 2008 which was $178 per day for a semi-private room in a nursing home, and $20 per hour for paid home care (MetLife, 2008). I assume if

[31]During my sample period, about 75 percent of policies offered such lifetime coverage options.

[32]This is the median premium (in 2013 dollars) of policies sold to healthy 60-year-olds in 2002 that have (1) a $100 maximum daily benefit (in 2002 dollars) that increases at the nominal annual rate of 5 percent, (2) no deductible, and (3) an unlimited benefit period (Brown and Finkelstein, 2007).

the parent enters a nursing home, she stays in the facility for the entire period, i.e., two years, and if she chooses paid home care, then she uses the service for 1,460 hours (14 hours per week) in case of light long-term care needs, and 2,920 hours (28 hours per week) in case of severe long-term care needs.

I set the Medicaid threshold for nursing home residents to zero. This is consistent with Medicaid's stringent restrictions on assets for nursing home residents.[33] I set the Medicaid threshold for paid home care users at $9,156 following Brown and Finkelstein (2008). I also use $9,156 for the consumption value of nursing home services and the SSI benefit for eligible paid home care users. The SSI benefit for nursing home residents is set at zero.

I consider three values of parental income, which correspond to the 20th, 55th, and 80th percentiles of the income distribution of the sample. Following Brown and Finkelstein (2008), I assume the per-period real interest rate is $r = 0.06$, corresponding to a 3 percent annual rate. I assume the child is 29 years younger than the parent, which is the average age difference between parents and children in the estimation sample.

4.3 Two-Stage CCP Estimation

To reduce the computational cost of estimating a dynamic game with rich individual level heterogeneity, I use a two-stage conditional choice probability (CCP) estimator pioneered by Hotz and Miller (1993) and Hotz, Miller, Sanders, and Smith (1994).[34] In the first stage, I obtain empirical estimates of the equilibrium decision rules (also known as empirical policy functions), which involves regressing the observed choices on the state variables. In the second stage, I use the empirical decision rules to forward simulate the model and estimate agents' value functions, which are then used as continuation value function estimates in constructing the pseudo likelihood. I search for structural parameter values θ that maximize the pseudo likelihood.[35] I now provide details of the estimation.

Policy function estimation. I start by estimating the equilibrium decision rules of the family, $P^* = (P^{K,*}, P^{P,*}, \sigma^{P,c,*})$, directly from the data. To estimate conditional choice probabilities $P^{K,*}$ and $P^{P,*}$, I use flexible logits. Specifically, to estimate $P^{K,*}$, I regress the child's employment and informal care hour choices (d_t^K) on flexible functions of common state variables (s_t). To estimate $P^{P,*}$, I regress the parent's insurance purchase or formal care utilization choices (d_t^P) on flexible functions of s_t and the child's choice in the current period (d_t^K). To estimate the parent's equilibrium consumption strategy, $\sigma^{P,c,*}$, I regress the log of imputed consumption from the CAMS

[33] Following Lockwood (2016), I do not use small positive values as it does little in changing the results of estimation while complicating the analysis.

[34] Aguirregabiria and Mira (2007), Bajari, Benkard, and Levin (2007), Pakes, Ostrovsky, and Berry (2007) and Pesendorfer and Schmidt-Dengler (2008) further developed CCP estimators in the context of dynamic games.

[35] The exact set of structural parameters that I estimate within the model is listed in Tables 7 and 8, and their notations are introduced in Appendix B.

data on flexible functions of s_t, d_t^K, and d_t^P. I denote the resulting empirical policy functions as $\hat{P} = (\hat{P}^K, \hat{P}^P, \hat{\sigma}^{P,c})$. Appendix Table C.1 compares simulated moments generated with these first-stage policy function estimates to data moments.

Value function estimation. Next, I estimate the equilibrium value functions, $V^{K,*}$ and $V^{P,*}$, using the empirical policy functions, $\hat{P}$. Following Hotz, Miller, Sanders, and Smith (1994) and Bajari, Benkard, and Levin (2007), I use forward simulation. For each state, I use $\hat{P}$ and the known distributions of shocks to obtain a simulated path of choices until the parent is dead. I repeat the simulation $N_S = 1,000$ times and average the child's and the parent's discounted sum of flow payoffs over the N_S simulated paths. As the agents' utility functions are linear in the structural parameters that I estimate, the forward simulation procedure is carried out only once, which greatly reduces the computational cost. I denote the estimated value functions as $\hat{V}^K$ and $\hat{V}^P$.

Pseudo maximum likelihood estimation. Finally, I use the estimated value functions to construct a *pseudo* likelihood function and search for the parameters that maximize this function. Intuitively, the pseudo likelihood function represents the likelihood that the child's and the parent's observed choices in a given period are their "current optimal" choices when they optimize in the current period, and starting in the next period, they behave according to $\hat{P}$, which may not be optimal.

Before I define the pseudo likelihood function, I first define the likelihood function, which can be obtained from fully solving the model. The data available for estimation consist of $\{s_{t_{n\tau}}, d^K_{t_{n\tau}}, d^P_{t_{n\tau}}; n = 1, ..., N, \tau = 1, ..., T_n\}$ where N is the number of parent-child pairs, and T_n is the number of interviews in which the nth parent-child pair is observed.[36] The likelihood function is given as

$$L^*(\theta) = \prod_{n=1}^{N} Pr(s_{t_{n1}}) \prod_{\tau=1}^{T_n-1} P^{K,*}(d^K_{t_{n\tau}}|s_{t_{n\tau}};\theta)P^{P,*}(d^P_{t_{n\tau}}|s_{t_{n\tau}}, d^K_{t_{n\tau}};\theta)Pr(s_{t_{n,\tau+1}}|s_{t_{n\tau}}, d^K_{t_{n\tau}}, d^P_{t_{n\tau}}) \quad (24)$$

where $P^{K,*}$ and $P^{P,*}$ are the optimal conditional choice probabilities obtained from solving the model backward at candidate parameter value θ. As there are no unobserved permanent types and all shocks are serially independent, the initial conditions can be treated as exogenous. The transition of the common state variables is deterministic except for the parent's wealth and health. While the parent's health transition is exogenous to the model, the conditional density of the parent's wealth in the next period depends on endogenous choices of the model. Using the wealth accumulation law in Equation (12), the conditional density of wealth is given as

$$\begin{aligned} f(w^P_{t+1}|s_t, d^P_t, c^P_t) &= f_m\left((1+r)(\hat{w}^P_t(s_t, d^P_t) - c^P_t) - w^P_{t+1}\right)^{\mathbb{I}(w^P_{t+1}>0)} \\ &\quad \times \left(1 - F_m\left((1+r)(\hat{w}^P_t(s_t, d^P_t) - c^P_t)\right)\right)^{\mathbb{I}(w^P_{t+1}=0)} \end{aligned} \quad (25)$$

[36] For pseudo maximum likelihood estimation, I do not use the parent's imputed consumption based on the CAMS data. I instead use the parent's wealth transition to incorporate the parent's consumption choices.

where f_m and F_m are the probability and the cumulative density functions of the parent's wealth shock, respectively. In place of c_t^P, I use the model's prediction on optimal consumption, $\sigma^{P,c,*}$. Getting rid of the terms that are irrelevant in estimating the structural parameters of the model, the likelihood function can be redefined as

$$L^*(\theta) = \prod_{n=1}^{N} \prod_{\tau=1}^{T_n-1} P^{K,*}(d_{t_{n\tau}}^K | s_{t_{n\tau}}; \theta) P^{P,*}(d_{t_{n\tau}}^P | s_{t_{n\tau}}, d_{t_{n\tau}}^K; \theta) f\Big(w_{t_{n,\tau+1}}^P \Big| s_{t_{n\tau}}, d_{t_{n\tau}}^P, \sigma^{P,c,*}(s_{t_{n\tau}}, d_{t_{n\tau}}^K, d_{t_{n\tau}}^P; \theta)\Big). \tag{26}$$

The pseudo likelihood function instead uses an approximation of $P^* = (P^{K,*}, P^{P,*}, \sigma^{P,c,*})$, thereby avoiding the need to solve the model. I repeat the steps (1)-(3) outlined in the model solution section (Section 3.3), but use $\hat{V}^K$ and $\hat{V}^P$ in place of equilibrium value functions. These steps can be summarized by the following:

(1) I obtain the parent's current optimal consumption by solving

$$\Psi^{P,c}(s_t, d_t^K, d_t^P; \hat{P}, \theta) = \underset{c_t^P \in (0, \hat{w}_t^P(s_t, d_t^P)]}{\operatorname{argmax}} \Big\{ \pi^P(c_t^P; \theta) + \beta E\Big[\hat{V}^P(s_{t+1}, d_{t+1}^K; \hat{P}, \theta) \Big| s_t, d_t^K, d_t^P, c_t^P; \hat{P}\Big] \Big\}. \tag{27}$$

(2) I obtain the parent's current optimal discrete choice probabilities as

$$\Psi^{P,d}(d_t^P | s_t, d_t^K; \hat{P}, \theta) = \frac{\exp\Big(\hat{v}^P(s_t, d_t^K, d_t^P; \hat{P}, \theta)\Big)}{\sum_{d_t^P \in \mathbb{C}^P(s_t, d_t^K)} \exp\Big(\hat{v}^P(s_t, d_t^K, d_t^P; \hat{P}, \theta)\Big)}. \tag{28}$$

(3) I obtain the child's current optimal discrete choice probabilities as

$$\Psi^K(d_t^K | s_t; \hat{P}, \theta) = \frac{\exp\Big(\hat{v}^K(s_t, d_t^K; \hat{P}, \theta)\Big)}{\sum_{d_t^K \in \mathbb{C}^K(s_t)} \exp\Big(\hat{v}^K(s_t, d_t^K; \hat{P}, \theta)\Big)}. \tag{29}$$

For $i \in \{K, P\}$, $\hat{v}^i$ is defined as in Equations (14) and (16) but $\hat{P}$ and $\hat{V}^i$ are used in place of σ and V^i. The function $\Psi = (\Psi^K, \Psi^{P,d}, \Psi^{P,c})$ is called the policy iteration operator or the policy improvement mapping as it updates the policy function estimates ($\hat{P}$) by embedding the agents' optimizing behaviors of the current period (Aguirregabiria and Mira, 2002). The pseudo likelihood function is given as

$$\begin{aligned} L(\theta; \hat{P}) = \prod_{n=1}^{N} \prod_{\tau=1}^{T_n-1} & \Psi^K(d_{t_{n\tau}}^K | s_{t_{n\tau}}; \hat{P}, \theta) \Psi^{P,d}(d_{t_{n\tau}}^P | s_{t_{n\tau}}, d_{t_{n\tau}}^K; \hat{P}, \theta) \\ & \times f\Big(w_{t_{n,\tau+1}}^P \Big| s_{t_{n\tau}}, d_{t_{n\tau}}^P, \Psi^{P,c}(s_{t_{n\tau}}, d_{t_{n\tau}}^K, d_{t_{n\tau}}^P; \hat{P}, \theta)\Big). \end{aligned} \tag{30}$$

The CCP estimator, denoted by $\hat{\theta}$, maximizes this pseudo likelihood function:

$$\hat{\theta} = \underset{\theta \in \Theta}{\operatorname{argmax}} \; L(\theta; \hat{P}). \tag{31}$$

This CCP estimator is consistent as the first-stage estimator of the equilibrium policy functions uses the flexible functions of the state variables and is therefore consistent (Aguirregabiria and Mira, 2007). To compute standard errors, I use bootstrapping as in Bajari, Benkard, and Levin (2007).

4.4 Identification

Before I present the estimation results, I provide heuristic arguments for identification of the structural parameters. I first discuss identification of the parameters that enter the child's utility functions. The child's consumption and leisure scale parameters are identified by variation in income and leisure across work and informal care choices. As children with healthy parents do not provide informal care, their choices help identify consumption and leisure parameters separately from warm-glow utility parameters.[37] The child's warm-glow utility is identified using the informal care choices of children whose parents have limited assets or are Medicaid eligible. This is because these children are not strategically motivated to provide help as their expected inheritance is almost zero. Informal care choices of children whose parents have long-term care insurance also provide a source of identification. As long-term care insurance companies pay for formal care costs, insured parents' children are less strategically motivated to provide informal care.

I now discuss identification of the parameters that enter the parent's utility functions. The parent's formal care choices identify the *differences* among formal care utilities.[38] The *levels* of formal care utilities are not identified from formal care choices.[39] As I normalize the utility from receiving informal care to zero, the levels of formal care utilities can be interpreted as how much the parent prefers formal care to informal care. So the parent's choices that affect the likelihood of receiving informal care identify these levels of formal care utilities. Long-term care insurance and savings are such choices. Purchasing long-term care insurance discourages the child's strategic incentive to provide care as insurance companies protect the bequests from formal care expenses, and savings influence the child's strategic informal care incentive by changing inheritances that are at stake.

[37] By warm-glow utility parameters, I refer to structural parameters that enter function ω^K in Equation (34) of Appendix B.

[38] The differences among formal care utilities are represented by parameters $\theta^P_{h^P_t, fc^P_t, \mathbb{I}[n^P \geq 4]}$ in Equation (36) of Appendix B.

[39] The levels of formal care utilities are represented by $\theta^P_{h^P_t}$ in Equation (36) of Appendix B. Note that $\theta^P_{h^P_t}$ is included in the parent's utility for all three formal care choices (no formal care, paid home care, and nursing home).

Table 7: Parent's Preference Parameter Estimates

Parameter	Notation	Estimate	S.E.
Bequest utility (10^{-5})	θ_d^P	2.305	0.192
Formal care utility when $h_t^P = 1$			
No long-term care	$\theta^P_{h_t^P=1}$	-6.297	1.391
Paid home care, 4- children	$\theta^P_{h_t^P=1, fc_t^P=\text{paid home care}, \mathbb{I}[n^P \geq 4]=0}$	1.277	0.065
Paid home care, 4+ children	$\theta^P_{h_t^P=1, fc_t^P=\text{paid home care}, \mathbb{I}[n^P \geq 4]=1}$	1.567	0.105
Nursing home, 4- children	$\theta^P_{h_t^P=1, fc_t^P=\text{nursing home}, \mathbb{I}[n^P \geq 4]=0}$	0.777	0.116
Nursing home, 4+ children	$\theta^P_{h_t^P=1, fc_t^P=\text{nursing home}, \mathbb{I}[n^P \geq 4]=1}$	0.313	0.157
Formal care utility when $h_t^P = 2$			
No formal care	$\theta^P_{h_t^P=2}$	-8.908	2.164
Paid home care, 4- children	$\theta^P_{h_t^P=2, fc_t^P=\text{paid home care}, \mathbb{I}[n^P \geq 4]=0}$	2.727	0.100
Paid home care, 4+ children	$\theta^P_{h_t^P=2, fc_t^P=\text{paid home care}, \mathbb{I}[n^P \geq 4]=1}$	1.653	0.098
Nursing home, 4- children	$\theta^P_{h_t^P=2, fc_t^P=\text{nursing home}, \mathbb{I}[n^P \geq 4]=0}$	3.912	0.108
Nursing home, 4+ children	$\theta^P_{h_t^P=2, fc_t^P=\text{nursing home}, \mathbb{I}[n^P \geq 4]=1}$	1.937	0.133

Notes: The table reports estimates for the parent's preference parameters. The exact utility function specification is provided in Appendix B. $h_t^P = 1$ and $h_t^P = 2$ denote light and severe long-term care needs, respectively. $fc_t^P \in \{\text{paid home care}, \text{nursing home}\}$ represents the formal care choice, and $\mathbb{I}[n^P \geq 4]$ is an indicator for having four or more children. Standard errors are computed using 50 bootstrap samples.

The parent's long-term care insurance and savings decisions are governed not only by her incentive to strategically influence the child, but also by her altruistic bequest motive. These two different motives are separately identified by the following argument. The parent's strategic motive affects the parent's insurance and savings decisions only through the child's informal care responses. Such responses are affected by the child's demographics that determine the cost of informal care. As the parent's altruistic bequest motive is unrelated to the child's demographics, child demographics serve as exclusion restrictions that identify the strategic bequest motive from the altruistic bequest motive.

Lastly, the parent's formal care choices are governed not only by formal care utilities but also by bequest motives. For example, the parent may not use formal care because she would rather increase bequests. Parents with long-term care insurance or Medicaid benefits help separate identification. This is because these parents' formal care choices are largely unaffected by bequest motives as they can use formal care without drawing down their wealth.

4.5 Estimation Results

Table 7 reports the parent's preference parameter estimates. Several findings emerge from the estimates. First, the parent prefers informal care to formal care. The estimates of $\theta^P_{h_t^P} + \theta^P_{h_t^P, fc_t^P, \mathbb{I}[n^P \geq 4]}$, which represent the parent's utility from using formal care fc_t^P in health status h_t^P, are always negative. As I have normalized the parent's preference for informal care to zero, the estimates imply

Table 8: Child's Preference Parameter Estimates

Parameter	Notation	Estimate	S.E.
Consumption scale	θ_c^K	1.384	0.032
Leisure scale	θ_l^K	0.844	0.034
Warm-glow utility			
$h_t^P = 1$, light informal care	$\theta^K_{h_t^P=1,ic_t^K=21\text{hrs/wk}}$	1.650	0.053
$h_t^P = 1$, intensive informal care	$\theta^K_{h_t^P=1,ic_t^K=42\text{hrs/wk}}$	1.273	0.067
$h_t^P = 2$, light informal care	$\theta^K_{h_t^P=2,ic_t^K=21\text{hrs/wk}}$	-0.567	0.037
$h_t^P = 2$, intensive informal care	$\theta^K_{h_t^P=2,ic_t^K=42\text{hrs/wk}}$	0.885	0.045
Male	θ^K_{male}	-1.236	0.046
Live far	θ^K_{far}	-1.332	0.044
Initiate caregiving	θ^K_{start}	-1.259	0.050

Notes: The table reports estimates for the child's preference parameters. The exact utility function specification is provided in Appendix B. $h_t^P = 1$ and $h_t^P = 2$ mean the parent has light and severe long-term care needs, respectively. Light and intensive informal care imply the child spends 21 hours and 42 hours per week, respectively, taking care of the parent. Standard errors are computed using 50 bootstrap samples.

that the parent has a distaste for formal care relative to informal care, consistent with Mommaerts (2015). Second, the parent's relative preferences for different formal care services vary by health status. Parents with light long-term care needs ($h_t^P = 1$) prefer paid home care to nursing home care.[40] This is consistent with the broad perception that most individuals want to remain in their homes and delay facility care until they absolutely need it. Preferences for nursing home care are substantially higher when the parent has severe long-term care needs ($h_t^P = 2$). Third, preferences for formal care are smaller for parents with many (four or more) children. So while the model abstracts away from interactions among multiple children, it is capable of replicating the empirical pattern that parents with four or more children use less formal care services. Lastly, the parent has altruistic bequest motives. To help understand the implications of the bequest utility parameter estimate, following Lockwood (2016), I compute the threshold consumption level below which, under conditions of perfect certainty or with full and fair insurance, parents do not leave bequests. The implied annual consumption threshold is $29,369, which is consistent with the estimates in the literature, ranging from $16,000 to $48,000 (De Nardi, 2004; De Nardi, French, and Jones, 2010; Lockwood, 2016).

Table 8 reports the estimates of the child's preference parameters. First, children prefer providing informal care to parents with light long-term care needs rather than severe long-term care needs. This is consistent with Skira (2015), who also finds higher informal care utility when the parent has modest rather than severe long-term care needs. Second, the psychological burden of providing care varies substantially by child demographics. Sons find the provision of informal care more burdensome than daughters, and children who do not live within 10 miles of their parents experience

[40]The estimates of nursing home preferences are net of consumption value from nursing home care as I have explicitly included the consumption value in the parent's consumption utility. Details are given in Appendix B.

Table 9: Model Fit for Unconditional Moments

	Data	Model
LTCI purchase rate	0.14	0.19
Among parents with light LTC needs		
Light informal care rate	0.37	0.37
Intensive informal care rate	0.18	0.11
Paid home care rate	0.50	0.50
Nursing home rate	0.07	0.05
Among parents with severe LTC needs		
Light informal care rate	0.09	0.04
Intensive informal care rate	0.29	0.28
Paid home care rate	0.30	0.32
Nursing home rate	0.36	0.30
Child employment rate	0.66	0.62

Notes: The informal care rates are among parents who have specified health statuses. The formal care rates are among parents who have specified health statuses and do not receive informal care from children.

higher utility costs than children who do. Third, there is a substantial cost in initiating informal care which may reflect switching or adjustment costs. As a result, the model generates persistence in informal care, consistent with Skira (2015).

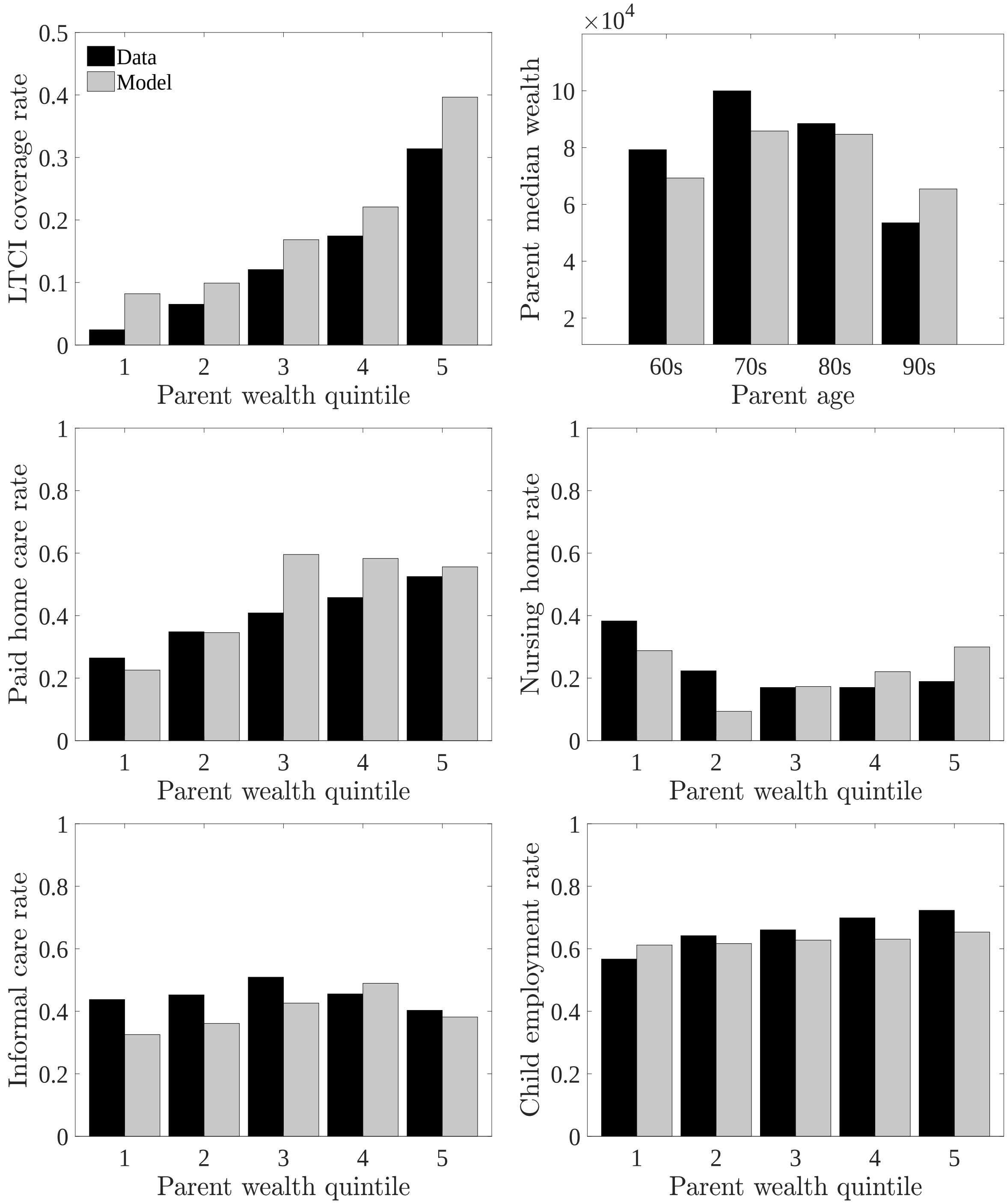
I now discuss the fit of the model. Table 9 shows that the model does a good job of matching unconditional moments in the data including the long-term care insurance purchase rate, informal and formal care rates, and child employment. In particular, the model is able to replicate the empirical pattern that informal care hours and nursing home utilization increase with the severity of the parent's health condition, while paid home care utilization decreases as the parent's health deteriorates.

In Figure 4, I show the fit for the parent's wealth evolution over the life-cycle, and various conditional moments by parent wealth quintile. The model replicates the empirical pattern that the long-term care insurance purchase rate increases monotonically in wealth, and the model also reproduces the inverted-U pattern of informal care across parent wealth, although the predicted pattern is slightly shifted to the right compared to the empirical counterpart.

Figure 5 shows the fit for conditional moments by family demographics. The model reproduces the empirical pattern that daughters and children residing in close proximity to parents are much more likely to provide informal care, and parents with four or more children are less likely to enter nursing homes compared to parents with three or less children.

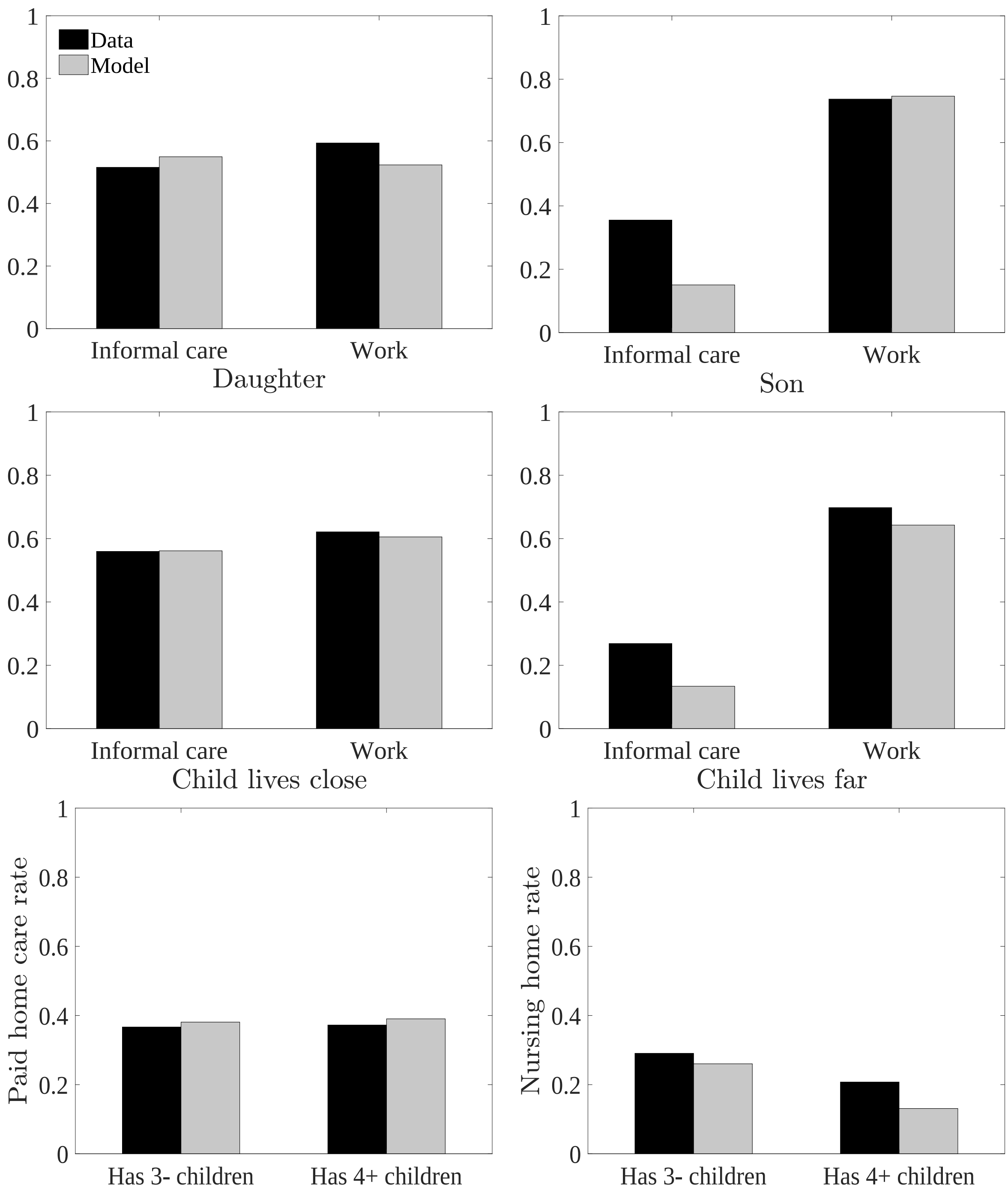
In Table 10, I show the fit for informal care transition probabilities. The model is capable of replicating the empirical persistence of informal care provision. Finally, Table 11 shows that the model-predicted lifetime formal care expenses for a healthy 65-year-old are consistent with the estimates in the literature.

Figure 4: Model Fit for Conditional Moments (1)



Notes: The paid home care and nursing home rates are among parents who have long-term care needs and do not receive informal care from children. The informal care rate is among parents with long-term care needs.

Figure 5: Model Fit for Conditional Moments (2)



Notes: "Child lives close" and "Child lives far" mean the child lives within and outside a 10 mile radius of the parent, respectively. The paid home care and nursing home rates are among parents who have long-term care needs and do not receive informal care from children. The informal care rate is among parents with long-term care needs.

Table 10: Model Fit for Informal Care Transitions

	No informal care	Informal care
No informal care	90%	10%
	[93%]	[7%]
Informal care	39%	61%
	[41%]	[59%]

Notes: The predicted moments are given in brackets. Informal care transitions are computed using children whose parents are alive for two consecutive periods.

Table 11: Model Fit for Lifetime Formal Care Expenses for a 65-year-old

	Literature	Model
Mean lifetime expenses	$55,930	$46,886
Mean lifetime expenses cond'l on ever using formal care	$96,431	$98,091
% of lifetime expenses paid by Medicaid	37%	32%

Notes: The table compares the present-discounted value of lifetime formal care expenses for a 65-year-old predicted by the model to the estimates in the literature. The values in the "Literature" column come from Kemper, Komisar, and Alecxih (2005/2006), inflated to 2013 dollars. All values are on a unisex basis.

5 Counterfactuals

To quantify the effects of family interactions on the insurance market equilibrium, I embed the estimated intergenerational game in an equilibrium long-term care insurance market. To incorporate the supply side of the market, I assume there are perfectly competitive risk-neutral insurance companies who sell the standard long-term care insurance policy (with features described in Section 3.1) to healthy 60-year-olds, and compete by setting premiums. Depending on the set of individual characteristics used in price setting, the market may be divided into multiple segments. For example, if gender were used in pricing, then there would be two market segments, one for men and one for women. While all healthy 60-year-olds faced the same price during the sample period, later in the section, I analyze the market equilibrium under counterfactual characteristic-based pricing. The equilibrium premium in each market segment, p^*, is determined by the zero profit condition which requires that insurance companies break even on average. Specifically, the equilibrium premium satisfies the following

$$p^* = \min\{p : AR(p) = AC(p)\} \tag{32}$$

where $AR(p)$ is the average present-discounted expected lifetime premium payments of consumers who buy insurance when the annual premium is p, and $AC(p)$ is their average present-discounted expected lifetime claims. Henceforth, I will refer to $AR(p)$ as the average revenue curve, and $AC(p)$ as the average cost curve.

For a given price of the standard long-term care insurance contract, the estimated intergenerational game predicts parents' demand for long-term care insurance and formal care utilization over

Table 12: Simulation Sample

	Mean	Median
Parents		
Married	0.75	
Female	0.57	
Wealth ($)	429,311	202,443
Have 4+ children	0.42	
Children		
Female	0.57	
Age	35	
College education	0.48	
Married	0.63	
Live within 10 mi of the parent	0.49	
Homeowner	0.52	
Observations	3,802	

Notes: The table reports the mean and the median values of the simulation sample. The simulation sample is constructed from the HRS 2000-2002, and it consists of parent-child pairs in which the parent is 60 years old and is healthy enough to purchase long-term care insurance based on underwriting guidelines in Hendren (2013). Wealth is measured in 2013 dollars.

the life-cycle, which are the main inputs in computing insurance companies' average revenue and cost. Crucially, the model predicts the average revenue and cost taking into account how they interact with informal care decisions of children. The parent in the model makes the insurance purchase decision with (correct) beliefs over the child's future informal care decisions, and the parent uses formal care only when the child decides not to provide informal care. This is in contrast to Brown and Finkelstein (2008) and Lockwood (2016) who study the demand for long-term care insurance without considering its interactions with the supply of informal care, and assume formal care utilization is an exogenous shock.

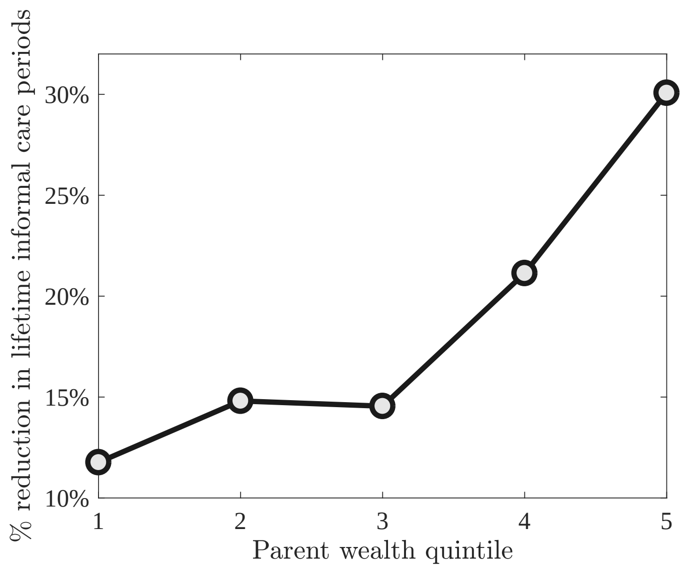
I apply the following algorithm to compute the insurance market equilibrium: (1) for a given price of long-term care insurance, I solve the intergenerational game backward using the structural parameter estimates, (2) I use the optimal decision rules of the family to forward simulate the model, (3) using simulated formal care and long-term care insurance choices of parents, I compute insurance companies' average revenue and cost, and (4) I repeat (1)-(3) until I find the premium at which firms' average revenue equals their average cost.[41] This market equilibrium approach is in contrast to Mommaerts (2015) who neglects the supply side and studies only the partial equilibrium effect of informal care.

I build the simulation sample by selecting healthy 60-year-olds from the HRS 2000-2002.[42] I

[41]When prices are assumed to vary by individual characteristics, I compute the equilibrium for each market segment.

[42]I use these interview waves for the following reason. Brown and Finkelstein (2008) use standard long-term care insurance policies sold in 2002 to compute the average mark up of the industry. To compare the mark up implied by my model to theirs, I use potential long-term care insurance buyers between 2000-2002.

Figure 6: Family Moral Hazard by Parent Wealth



Notes: The figure reports for each parent wealth quintile at age 60, the percentage reduction in lifetime informal care periods as parents move from the No LTCI Regime to the Mandatory LTCI Regime.

do not restrict the sample to single individuals because during the sample period, all healthy 60-year-olds paid the same price regardless of their marital status.[43] I match one adult child to each parent such that the simulation sample has similar child demographic composition as the estimation sample. Table 12 presents the summary statistics of the simulation sample consisting of 3,802 parent-child pairs. I make 100 duplicates for each parent-child pair to increase the sample size. Using the simulation sample, I compute the insurance market equilibrium when all healthy 60-year-olds face the same price. The equilibrium annual premium is computed as $5,729 and the equilibrium coverage rate is 11.5 percent. This is the benchmark insurance market equilibrium that I use in this section, as there was a single market for all healthy 60-year-olds during the sample period.

5.1 Effects of Strategic Interactions

I first consider by how much children strategically reduce informal care in response to parents' insurance purchase. This "crowd-out" effect of long-term care insurance on children's informal care provision is also known as the *family moral hazard* effect (Pauly, 1990; Courbage and Zweifel, 2011). To this end, I simulate the model under two different assumptions: (1) no parent can purchase long-term care insurance (No LTCI Regime), and (2) every parent has to purchase long-term care insurance at the benchmark equilibrium premium of $5,729 (Mandatory LTCI Regime).

[43] As the model is estimated using single parents, the estimated model may overpredict informal care from children for married individuals. However, this issue is mitigated by the fact that (1) long-term care needs are late-life risks and (2) the share of singles increases sharply with age.

Table 13: Effects of Family Moral Hazard

	LTCI coverage rate	Annual premium ($)	AC ($)
Benchmark equilibrium	0.115	5,729	77,068
Partial equilibrium without FMH	0.158	5,729	67,399
New equilibrium without FMH	0.188	4,859	66,865

Notes: The table reports the long-term care insurance coverage rate, annual premium, and average present-discounted value of lifetime claims of insured parents (AC) under each of the specified equilibrium scenarios. The first row reports the market equilibrium of the benchmark model where children can respond to parents' long-term care insurance purchase. The second row reports the partial equilibrium outcomes when there is no family moral hazard and the premium is held constant at the benchmark equilibrium premium. The third row reports the new long-term care insurance market equilibrium when there is no family moral hazard. Under no family moral hazard scenario, children whose parents own long-term care insurance are forced to make the same informal care choices as they would when their parents did not own insurance.

Figure 6 reports for each quintile of the parent wealth at age 60, the average percentage reduction in informal care periods over the parent's life-cycle as parents move from the No LTCI Regime to the Mandatory LTCI Regime. On average, the purchase of long-term care insurance reduces the number of informal care periods over the parent's life-cycle by almost 20 percent.

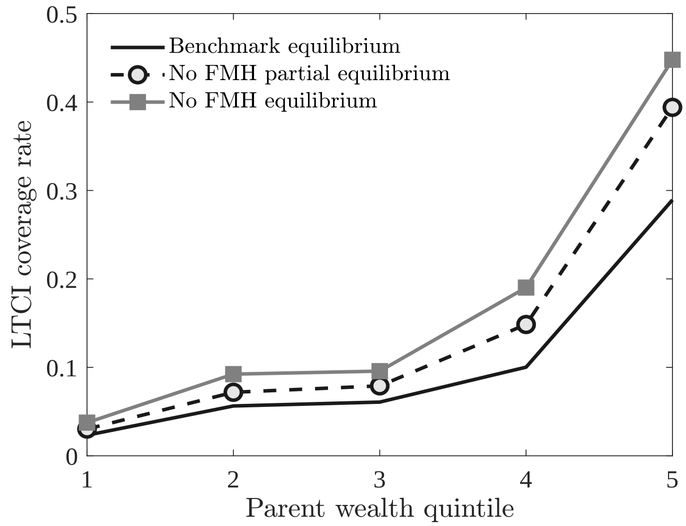
Figure 6 shows that most of the reduction in informal care comes from children whose parents are in the upper 30 percent of the initial wealth distribution. The intuition for this result is the following. For parents who are initially very poor, their children's informal care decisions are largely governed by the warm-glow utility as there is almost no wealth to inherit. So whether the parent purchases insurance has the minimal effect in the child's informal care decisions. This is true even for parents who are initially in the middle of the wealth distribution because they "spend down" their assets to Medicaid eligibility, as found in Brown and Finkelstein (2008). In contrast, the high-wealth parents experience a larger family moral hazard effect, suggesting that strategic informal care provision is the most relevant for wealthy parents who have enough wealth to incentivize children using bequests and do not spend down to Medicaid eligibility.

To quantify how family moral hazard affects the long-term care insurance market equilibrium, I simulate the model assuming the purchase of long-term care insurance does not reduce children's informal care provision, i.e., there is no family moral hazard. Specifically, I force the child whose parent purchases long-term care insurance to make the same informal care choices as the child would when the parent did not purchase insurance. An alternative version of the model with full commitment could deliver this outcome.[44]

Table 13 summarizes the results. To serve as the benchmark, the first row of the table reports the insurance market equilibrium when the child is allowed to show behavioral responses to the parent's purchase of insurance, i.e., family moral hazard is present. The second row reports the counterfactual results when there is no family moral hazard and the premium is held constant at

[44] Adding the assumption that "the parent hides the purchase of insurance from the child" to the intergenerational game does not fully eliminate family moral hazard. This is because by the Bayes' rule, the child will correctly infer the parent's insurance purchase probability in equilibrium.

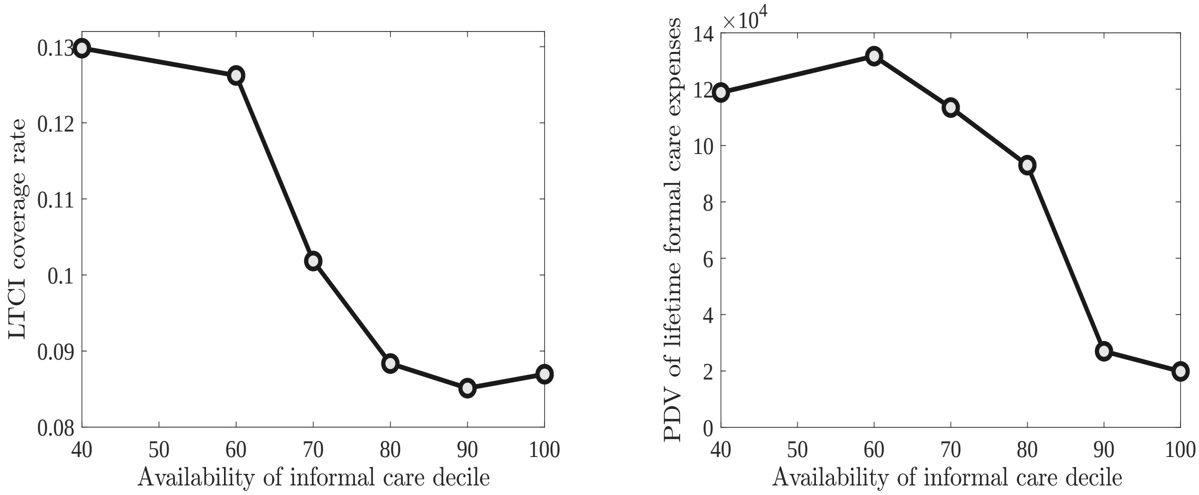
Figure 7: LTCI Coverage Effects of Family Moral Hazard by Parent Wealth



Notes: The figure reports the long-term care insurance coverage rate by parent wealth for each of the three specified equilibrium scenarios. The black solid line (Benchmark equilibrium) represents the insurance coverage rate of the benchmark model where children can respond to parents' long-term care insurance purchase. The dashed line (No FMH partial equilibrium) represents the coverage rate when there is no family moral hazard but the premium is held constant at the benchmark equilibrium premium. The gray solid line (No FMH equilibrium) represents the coverage rate when there is no family moral hazard and the premium is adjusted to the new break-even level. Under no family moral hazard scenario, children whose parents own long-term care insurance are forced to make the same informal care choices as they would when their parents did not own insurance.

the benchmark equilibrium premium of $5,729. The demand for insurance increases from 0.115 to 0.158, corresponding to an almost 40 percent increase. Figure 7 shows that most of the increase comes from wealthy parents whose children have the greatest strategic incentive to provide care. In the absence of family moral hazard, there is a noticeable reduction in the average cost to insurance companies, as reported in the "AC" column of Table 13. As children do not reduce informal care hours in response to parents' insurance purchase, parents with long-term care insurance are now less likely to use formal care services. The equilibrium premium will be adjusted to reflect the reduction in the average cost which is reported in the third row of the table; the equilibrium premium drops to $4,859 and the coverage rate further increases to 0.188. To sum, there is substantial strategic non-purchase of insurance reducing the equilibrium long-term care insurance coverage rate from 19 percent to 11 percent. This is the first estimate for the effect of strategic bequest motives on insurance choices of the elderly and provides empirical evidence for relevant theoretical studies such as Bernheim, Shleifer, and Summers (1985), Pauly (1990), Zweifel and Struwe (1996), and Courbage and Zweifel (2011).

Figure 8: Informal Care and Insurance Selection



Notes: The left panel reports, for each decile of the informal care availability measure, the fraction of parents who buy long-term care insurance at the benchmark equilibrium premium of $5,729. The right panel reports, for each decile of the informal care availability measure, the average present-discounted value of the lifetime formal care expenses under the Mandatory LTCI Regime where all parents must purchase long-term care insurance. The informal care availability is defined as the number of informal care periods divided by the number of bad health periods when there is no private long-term care insurance. Quantiles start at the 40th percentile because there is a big mass at zero (about 55 percent of parents never receive informal care). This is consistent with the data patterns; Table 4 shows that among parents with long-term care needs, 55 percent do not receive any informal care from children.

5.2 Effects of Private Information about Children's Informal Care Provision

Next, I quantify how private information about children's informal care provision affects selection in the long-term care insurance market. I focus on this particular dimension of private information rather than, for example, unobserved health, because the tests for private information presented in Section 2 show that individual beliefs about children's informal care provision are the key dimension of private information in the long-term care insurance market. As parents with a low chance of receiving informal care have higher expected formal care spending and hence higher willingness to pay for long-term care insurance, there is adverse selection based on individual beliefs about children's informal care provision.

Figure 8 shows the magnitude of this selection. The left panel reports for each decile of the "availability of informal care", the fraction of parents who purchase insurance at the benchmark equilibrium premium of $5,729. I measure the availability of informal care as the lifetime likelihood of receiving informal care when the parent does not purchase long-term care insurance.[45] The negative slope confirms that parents who expect a low chance of receiving informal care are more

[45]This is computed from simulating the model under the No LTCI Regime. For each family in the simulation sample, I measure the "availability of informal care" as the number of informal care periods divided by the number of unhealthy periods over the parent's life-cycle.

likely to select into insurance. Quantitatively, moving from the 10th percentile to the 90th percentile of the distribution for the availability of informal care is associated with a 4.5 percentage point decrease in the demand for insurance, which is substantial given the equilibrium coverage rate of 11.5 percent. To quantify how adverse this selection is, the right panel of Figure 8 reports, for each decile of the availability of informal care, the average present-discounted value of lifetime formal care expenses. Qualitatively, the slope is negative as expected. Quantitatively, moving from the 10th percentile to the 90th percentile of the distribution is associated with an almost $100,000 reduction in lifetime formal care expenses.

To sum, private information about children's informal care provision hinders the efficient workings of the long-term care insurance market by attracting a disproportionate number of individuals with worse informal care options and hence higher expected formal care spending. Individuals with a greater chance of receiving informal care, who nevertheless value financial protection against formal care spending risks, forgo long-term care insurance owing to adverse selection.

5.3 Effects of Counterfactual Risk Adjustment

To reduce the amounts of private information about informal care options, I now consider counterfactual risk adjustment whereby an individual's long-term care insurance premiums are adjusted based on observables that are predictive of expected informal care provision from children. In the long-term care insurance market, there is no direct regulation of individual covariates used to set insurance prices. Despite this, premiums varied only by age and three or four health underwriting classes until 2013 when gender-based pricing was introduced following a massive exit of insurance companies, who attributed their exits to factors including worse-than-expected adverse selection.[46] Gender-based pricing helps to reduce adverse selection as women have a higher chance of having functional limitations than men (see Table 6). This subsection demonstrates that adjusting premiums based on family characteristics that are predictive of children's expected informal care provision generates a greater reduction in adverse selection and a larger welfare gain than gender-based pricing.

To identify observables that are predictive of expected informal care provision by children, I first use the HRS question described in Section 2.2 which directly asks respondents whether they expect to receive informal care from children in the future. Using a sample of healthy individuals aged between 60-65 who represent potential buyers of long-term care insurance, I regress the responses on a set of covariates including wealth, income, individual and family demographic characteristics. The result, reported in Appendix Table C.2, shows that in addition to gender, the number of children, and the presence of a daughter and a child living within 10 miles to the respondent are the key predictors. This reduced-form result is consistent with the estimated intergenerational game which also predicts that daughters and children living close to their parents provide more informal care, and parents with four or more children rely less on formal care services compared to

[46] Source: Society of Actuaries.

Table 14: Effects of Counterfactual Risk Adjustment

Priced observables	Avg premium ($/yr)	LTCI coverage rate	*AC* ($)	Avg welfare ($)
Default	5,729	0.115	77,068	0
Gender	5,972	0.118	73,134	2,430
Child demographics 1	5,366	0.122	73,759	3,887
Child demographics 2	4,997	0.136	65,588	5,422

Notes: The table reports the insurance market equilibrium outcomes under various pricing rules. The first row (Default) reports the market equilibrium under default risk adjustment where all healthy 60-year-olds pay the same price. The second row (Gender) reports the market equilibrium when prices are conditional on the gender of a consumer. The third row (Child demographics 1) reports the market equilibrium when prices are conditional on whether the consumer has four or more children and daughter. The fourth row (Child demographics 2) reports the market equilibrium when prices are conditional on whether the consumer has four or more children, a daughter, and a child living in a 10 mile radius. Except for the first row where there is a single market segment, "Avg premium" represents the average break-even premium of multiple market segments, weighted by the share of consumers in each segment. *AC* represents the average present-discounted value of the lifetime claims of insured parents. Welfare is computed as the wealth transfer needed to make a parent under the default pricing rule indifferent to the new pricing rule. "Avg welfare" is the average welfare among parents whose welfare is reduced or increased by at least $100.

parents with fewer children (see Figure 5). I also regress the simulated informal care choices from the model on initial state variables, and find that these demographics are the key predictors.

I therefore consider counterfactual risk adjustment where premiums are adjusted based on (1) whether the parent has four or more children, (2) whether the parent has a daughter, and (3) whether the parent has a child living in a 10 mile radius of the parent. Under this risk adjustment, there are $2^3 = 8$ market segments. I divide the simulation sample into 8 groups accordingly, and compute the insurance market equilibrium for each of the 8 market segments. I compute the welfare effect of characteristic-based pricing as the wealth transfer needed to make a parent under default pricing, where all healthy 60-year-olds face the same price, indifferent to characteristic-based pricing.

While children's residential proximity to parents is a key predictor of their informal care provision, if insurance prices depended on this characteristic, then it might be subject to strategic change. For example, a potential buyer might live with her child only until she purchases long-term care insurance. Such issues could be alleviated if insurance companies added the contractual provision that policyholders are subject to a premium increase in case of a change in the priced characteristics.[47] Nevertheless, to be conservative about the effects of counterfactual risk adjustment, I also compute the insurance market equilibrium when insurance prices vary only by whether the parent has four or more children and a daughter.

Table 14 summarizes the results.[48] To make a comparison to newly adopted gender-based pricing,

[47]For example, place of residence is used the U.S. automobile insurance market and the U.K. annuity market in pricing contracts.

[48]In Appendix C, I report the insurance market equilibrium for each of the market segments under counterfactual risk adjustment.

the table also reports the market equilibrium when prices vary by parent gender. The table shows that adjusting premiums based on child demographics generates a larger welfare gain than gender-based pricing; the average welfare effect of gender-based pricing is less than $2,500, but using the number of children and the presence of a daughter generates the average welfare of almost $4,000, and additionally using the presence of a child living in proximity generates the average welfare of almost $5,500. These welfare gains are generated by expanding the insurance coverage to parents whose child demographics predict a high chance of receiving informal care. Under default risk adjustment, these parents refrain from purchasing insurance as the premium is set too high relative to their expected formal care expenses. As the relatively low-cost parents select into insurance under child demographic-based pricing, the average cost to insurance companies declines which lowers the average break-even premium. Taken together, these findings imply that using child demographics in pricing long-term care insurance contracts is more effective in reducing adverse selection and increasing the average welfare of the elderly than newly adopted gender-based pricing of the industry.

It should be noted that using individual characteristics in setting insurance prices may be costly to insurance companies in a way that is not captured in my analysis. For example, insurance companies may be concerned that using child demographics in pricing could lead to regulatory response or consumer backlash.[49] Unpacking insurance companies' decision of which observables to price on when there is non-trivial explicit or implicit screening cost is an interesting direction for future work.

5.4 Application: What Explains the Recent Premium Increases?

In the last decade, there was a massive exit of insurance companies in the long-term care insurance market. The number of companies selling new contracts has plunged from over 100 to a dozen.[50] The insurance companies reported huge losses due to underpriced policies from older blocks of sales, and almost all insurance companies sought approvals from the state governments to increase premiums on existing policies.[51] For example, in August 2016, John Hancock Life who exclusively contracts with the federal government to provide long-term care insurance to federal employees was given the permission to increase the rates by an average of 83 percent for nearly all of its existing policies.[52] Genworth, the biggest long-term care insurance company, also requested rate increases of 80-85 percent on policies sold before 2011 in most states.[53]

[49]See Finkelstein and Poterba (2014) for a discussion about potential explanations for "unused observables" in insurance markets.

[50]Source: National Association of Insurance Commissioners (NAIC).

[51]Source: Broker World and NAIC.

[52]https://www.forbes.com/sites/howardgleckman/2016/08/01/another-big-long-term-care-insurance-premium-hike/#334c7d1d42a4.

[53]https://www.nytimes.com/2015/09/03/your-money/managing-the-costs-of-long-term-care-insurance.html.

The sharp premium increases that took place on the basis of underpricing are in contrast to the existing finding in the literature. Brown and Finkelstein (2007) use an actuarial model of health and formal care utilization probabilities and argue that premiums in 2002 had an average mark up of 18 percent. In contrast, my model predicts that typical policies in 2002 were priced below the zero-profit premium by almost 80 percent; the model-implied break-even premium for the standard policy is $5,729 per year, but such standard policies had an average annual premium of $3,195 in 2002 (Brown and Finkelstein, 2007). Model-implied underpricing of almost 80 percent is largely consistent with the requested premium increases from major long-term care insurance companies on their older blocks of policies, as mentioned above.

The reason why I find such a high break-even premium in contrast to Brown and Finkelstein (2007) is the following. They employ an actuarial model that is widely used by long-term care insurance companies to set premiums.[54] This actuarial model assumes that formal care utilization probabilities are the same for those who purchase and do not purchase insurance (i.e., no selection), and completely neglects the possibility of receiving informal care. The actuarial model predicts formal care utilization transition probabilities conditional only on age, initial health, and gender.[55] In contrast, my model incorporates rich interactions between the insurance demand, formal care utilization, and informal care supply. In particular, the family moral hazard effect and adverse selection based on beliefs about children's informal care provision act as main factors in increasing firms' costs and hence the break-even premium.

The discrepancy between the break-even premiums predicted by my model and the widely used actuarial model suggests that insurance companies may have underestimated the importance of family interactions in predicting the formal care utilization risk. The fact that insurance companies do not collect any information about children from consumers provides further support for this possibility. While other factors may also have contributed to underpricing and sizable losses (for example, lower-than-expected lapse rates or high capital requirements), the fact that the market rate seems to be converging to the model-implied equilibrium premium increases the credibility of my argument, and also serves as external validation of the model.

Finally, I discuss the timing of the premium increases. While people on average purchase long-term care insurance in their sixties, most of them do not use it until they turn 80. For example, the average age at first entry into a nursing home is around 83 years (Brown and Finkelstein, 2007). As modern long-term care insurance products were introduced in the late 1980s, it has only been a few years since insurance companies gained access to sufficient claims data and became capable of comparing realized and assumed formal care risks of their policyholders.

[54] See Brown and Finkelstein (2007) for more details about the widespread use of this actuarial model.

[55] For more details about the actuarial model, see Robinson (1996, 2002).

6 Conclusion

I have developed and estimated a dynamic intergenerational game in which elderly parents and adult children interact non-cooperatively from parents' retirement to death. The model features parents' long-term care insurance choice, formal care utilization, and savings, and children's informal care provision and labor supply. The model incorporates strategic non-purchase of insurance where parents refrain from purchasing long-term care insurance because they are concerned that insurance would diminish children's strategic informal care provision. The "crowd-out" effect of long-term care insurance on informal care provision arises because with insurance, children no longer have to provide informal care to prevent depletion of inheritance on formal care. The model also incorporates rich child and parent level heterogeneity which results in heterogeneous informal care likelihood across families, allowing for the analysis of insurance selection based on this dimension of private information.

The model is estimated using the Health and Retirement Study 1998-2010 and actual premium data over the sample period by the CCP estimation method. The estimated model is able to fit the most important features of the data. I then embed the estimated model within an equilibrium long-term care insurance market. To do this, I introduce perfectly competitive risk-neutral insurance companies that make zero profits in equilibrium. As the estimated intergenerational game predicts, for a given price of long-term care insurance, the insurance demand and the expected formal care spending, I iteratively solve the game until I find the break-even price leading to zero profits.

Using the equilibrium insurance market framework, I quantify the effects of family interactions and explore welfare-increasing policies. First, I find quantitatively meaningful strategic non-purchase of insurance which is the most salient among wealthy parents. Second, private information about children's informal care provision results in adverse selection where individuals with worse family care options and hence higher expected formal care spending are more likely to select into insurance. Finally, I demonstrate that using family characteristics in pricing long-term care insurance contracts reduces adverse selection and generates welfare gains.

Challenges in the long-term care sector, such as the aging of the baby boom generation, increasing burdens of informal caregivers, and growing Medicaid spending on formal care, have triggered various policy recommendations. They include the government providing family care subsidies and insurance companies paying cash to informal caregivers. Such recommendations are non-market-based which could lead to even bigger efficiency costs, or involve drastic changes in the structure of the insurance products and raise doubts about the practicality. In contrast, my proposal of using family demographics in pricing is market-based and is already in momentum; the fact that insurance companies have started to price on consumer gender makes my proposal well-grounded.

I conclude by discussing limitations of my analysis. First, I assume elderly individuals have homogeneous risk aversion. However, if there were a negative correlation between risk aversion and expected formal care spending, then the magnitude of adverse selection in the long-term care insurance market would be smaller. Second, I study decisions of one single parent and one child, and abstract away from interactions among spouses or multiple children over long-term care decisions. Third, my analysis does not incorporate savings on the child side. This is primarily because I do not observe children's assets in the data. The assumption that the child cannot save may underestimate the cost of informal care, as caregiving children are usually in their prime saving years. Fourth, I incorporate only one type of long-term care insurance contracts, where as in reality, insurance companies offer contracts of various benefit amounts. The exploration of such considerations is left for future research.

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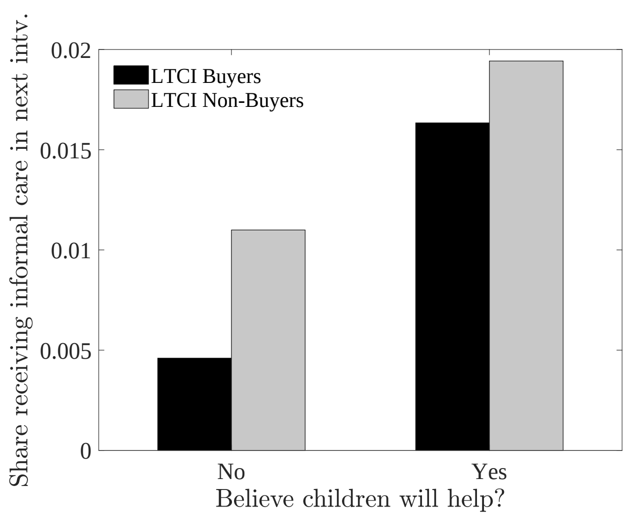
Appendix

A Descriptive Evidence on Family Moral Hazard

I provide descriptive evidence that parents' decision to buy long-term care insurance undermines children's informal care incentives. Children's informal care behaviors may be affected not only by parents' long-term care insurance coverage but also by other important factors such as the opportunity costs of providing care. To better control for the determinants of informal care provision other than long-term care insurance coverage, I again take advantage of the subjective beliefs about informal care reported in the HRS (see Section 2.2 for the description of these beliefs). Using healthy respondents who do not yet own long-term care insurance in the current interview, I split the sample by their beliefs about informal care in the current interview and long-term care insurance purchase choices in the next interview. For each of the four subsamples, I compute the share of respondents who receive informal care from children in the next interview. The goal is to see if respondents who buy long-term care insurance receive less informal care *conditional on* beliefs about informal care before the insurance purchase. Figure A.1 shows that, conditional on beliefs about informal care, parents who buy long-term care insurance are indeed less likely to receive care from children.

Figure A.1: Long-Term Care Insurance Purchase and Informal Care



Notes: Sample is limited to healthy individuals who do not yet own long-term care insurance in the current interview. I split the sample by their current beliefs about the availability of informal care and long-term care insurance purchase choices in the next interview. For each of the four subsamples, the figure reports the share receiving informal care from children in the next interview.

B Model Details

In this appendix, I provide details about the model presented in Section 3.

B.1 Utility Functions

Child's preference while the parent is alive.

$$\pi^K(c_t^K, l_t^K, ic_t^K; h_t^P, ic_{t-1}^K, X^K) = \theta_c^K \frac{(c_t^K)^{1-\rho_c^K} - 1}{1-\rho_c^K} + \theta_l^K \frac{(l_t^K)^{1-\rho_l^K} - 1}{1-\rho_l^K} + \omega^K(ic_t^K; h_t^P, ic_{t-1}^K, X^K) \tag{33}$$

where

$$\omega^K(ic_t^K; h_t^P, ic_{t-1}^K, X^K) = \begin{cases} 0 & \text{if} \quad ic_t^K = 0, \\ \theta^K_{h_t^P, ic_t^K} + \theta^K_{male}\mathbb{I}[male^K] + \theta^K_{far}\mathbb{I}[far^K] + \theta^K_{start}\mathbb{I}[ic_{t-1}^K = 0] & \text{if} \quad ic_t^K > 0. \end{cases} \tag{34}$$

The child's consumption and leisure preferences follow a constant relative risk aversion utility function, and function ω^K represents the child's preference for providing informal care. The child's utility from providing no informal care is normalized to zero and the child's informal care choice is set to $ic_t^K = 0$ when the parent is healthy.[56] $\mathbb{I}[male^K]$ is an indicator for the child being a male, $\mathbb{I}[far^K]$ is an indicator for the child living far from the parent, and $\mathbb{I}[ic_{t-1}^K = 0]$ is an indicator for not providing any informal care in the previous period. The inclusion of these indicators is based on the data patterns that informal care behaviors of children vary substantially by gender and residential proximity to parents, and there is persistence in informal care provision.

Parent's preference while she is alive.

$$\pi^P(c_t^P, fc_t^P, ic_t^K; h_t^P, n^P) = \theta_c^P \frac{(c_t^P + c_{nh}\mathbb{I}[fc_t^P = \text{nursing home}])^{1-\rho_c^P} - 1}{1-\rho_c^P} + \omega^P(fc_t^P, ic_t^K; h_t^P, n^P). \tag{35}$$

The parent's consumption preference follows a constant relative risk aversion utility function, $\mathbb{I}[fc_t^P = \text{nursing home}]$ is an indicator for the parent choosing nursing home services, and c_{nh} is the consumption value from residing in a nursing home.[57] The function ω^P represents the parent's

[56] In the data, almost no children provide care to healthy parents.

[57] For the empirical specification of the model, I calibrate the parent's consumption scale parameter, θ_c^P, to match empirical consumption and the calibrated value is $\theta_c^P = 4.671 * 10^9$.

long-term care utility and is specified as

$$\omega^P(fc_t^P, ic_t^K; h_t^P, n^P) = \begin{cases} 0 & \text{if } ic_t^K > 0, \\ \theta^P_{h_t^P} & \text{if } ic_t^K = 0 \text{ and } fc_t^P = \text{no formal care}, \\ \theta^P_{h_t^P} + \theta^P_{h_t^P, fc_t^P, \mathbb{I}[n^P \geq 4]} & \text{if } ic_t^K = 0 \text{ and } fc_t^P \in \{\text{paid home care}, \text{nursing home}\}. \end{cases} \tag{36}$$

When the child provides informal care, $ic_t^K > 0$, the parent never uses formal care and I normalize the parent's utility from receiving informal care to zero. The parent makes a formal care utilization choice only when she has long-term care needs, $h_t^P \in \{1, 2\}$, and the child provides no informal care, $ic_t^K = 0$. If the parent chooses not to use any formal care, then she experiences $\theta^P_{h_t^P}$. So $\theta^P_{h_t^P}$ can be interpreted as the parent's disutility from not receiving any long-term care when her health status is h_t^P. If the parent uses formal care $fc_t^P \in \{\text{paid home care}, \text{nursing home}\}$, then she experiences a utility gain of $\theta^P_{h_t^P, fc_t^P, \mathbb{I}[n^P \geq 4]}$ which depends on the parent's health status and whether or not she has four or more children. The dependence upon the number of children is to reflect the possibility that the child within the model may not be the only source of informal care, and to rationalize the data pattern that parents with many children use less formal care. As the parent's utility from receiving informal care is normalized to zero, the levels of $\theta^P_{h_t^P} + \theta^P_{h_t^P, fc_t^P, \mathbb{I}[n^P \geq 4]}$ can be interpreted as how much the parent prefers formal care to informal care. When the parent is healthy, there is no informal care provision by the child nor any formal care utilization by the parent, and I normalize ω^P to zero.[58]

Child's inheritance preference. I use two empirical facts to determine the child's share of the bequest. First, caregiving children, on average, receive bequest amounts that are twice as much as those received by non-caregiving children (Groneck, 2016). Second, the average number of children in the data is around three. Based on these, I assume that the child in the model inherits one half of the parent's wealth. The child's value from this inheritance is determined by assuming that the child optimally consumes the inheritance over the next T_0 periods.[59] Given that the child is risk-averse, she will allocate the inheritance equally over the next T_0 periods. Let x denote the equally allocated amount. Using $\beta = \frac{1}{1+r}$, I obtain $x = 0.5 w_t^P \frac{1-\beta}{1-\beta^{T_0}}$. As the child's income is likely to affect the consumption value of the inheritance, I assume that the child receives a constant income, y, over the next T_0 periods. This constant income depends on whether the child has some college education. I use the average child income conditional on college education to set the values of y. In each of the next T_0 periods since the parent's death, the child therefore consumes $y + x$, and the child's terminal value is computed as the discounted sum of the consumption utilities over

[58]This normalizing value has no impact on the model as the health transition probabilities are exogenous to the choices made within the model.

[59]I use $T_0 = 5$.

the next T_0 periods:

$$\pi_d^K = \theta_d^K \frac{1-\beta^{T_0}}{1-\beta} \frac{(y+x)^{1-\rho_c^K}-1}{1-\rho_c^K} \tag{37}$$

where θ_d^K is the inheritance scale parameter. For the empirical specification of the model, I calibrate θ_d^K to match the informal care rate by parent wealth and parent age, and the calibrated value is $\theta_d^K = 4.560$.

B.2 Child's Income Function

The HRS reports the annual family income of the respondents' children as bracketed values: below \$10K, between \$10K-35K, between \$35K-70K, above \$35K, and above \$70K. I put children in the "above \$35K" bracket into the "\$35K-70K" bracket. As each period is two years in my model, I double the threshold values and define $\hat{y}_i^K$ by the following:

$$\hat{y}_i^K = \begin{cases} 1 & \text{if below \$20K,} \\ 2 & \text{if between \$20K-70K,} \\ 3 & \text{if between \$70K-140K,} \\ 4 & \text{and if above \$140K} \end{cases} \tag{38}$$

where subscript i indexes each observation in the HRS data. I assume there is an underlying continuous family income, $\tilde{y}_i^K$, which is defined by the following equation

$$\log(\tilde{y}_i^K) = x_i^K \gamma + \eta_i \tag{39}$$

where

$$\begin{aligned} x_i^K \gamma = {} & \gamma_{1,1} + \gamma_{1,2} age_i^K + \gamma_{1,3} (age_i^K)^2 + \gamma_{1,4} home_i^K + \gamma_{1,5} edu_i^K + \gamma_{1,6} female_i^K \\ & + \gamma_{1,7} female_i^K * married_i^K + \gamma_{1,8} (1 - female_i^K) * married_i^K \\ & + e_i^K * \Big\{ \gamma_{2,1} + \gamma_{2,2} age_i^K + \gamma_{2,3} (age_i^K)^2 + \gamma_{2,4} female_i^K + \gamma_{2,5} edu_i^K \\ & + \gamma_{2,6} female_i^K * (e_{i,-1}^K) + \gamma_{2,7} (1 - female_i^K) * (e_{i,-1}^K) \Big\}. \end{aligned}$$

$home^K$ is an indicator for the child being a homeowner, edu^K is an indicator for the child having some college education, $female^K$ is an indicator for the child being female, $married^K$ is an indicator for the child being married, e_i^K is an indicator for the child working full-time, and $e_{i,-1}^K$ is an indicator for the child child working full-time in the previous period. I assume η_i follows an *i.i.d.* normal distribution with mean zero and variance σ_η^2. The log likelihood function is given by

$$\log L(\gamma, \sigma_\eta | \hat{y}^K, x^K) = \sum_i \log P(\hat{y}_i^K | x_i^K; \gamma, \sigma_\eta) \tag{40}$$

where

$$\begin{aligned}
P(\hat{y}_i^K = 1 | x_i^K) &= \Phi_{\sigma_\eta}(\log(20K) - x_i^K \gamma | x_i^K), \\
P(\hat{y}_i^K = 2 | x_i^K) &= \Phi_{\sigma_\eta}(\log(70K) - x_i^K \gamma) - \Phi_{\sigma_\eta}(\log(20K) - x_i^K \gamma), \\
P(\hat{y}_i^K = 3 | x_i^K) &= \Phi_{\sigma_\eta}(\log(140K) - x_i^K \gamma) - \Phi_{\sigma_\eta}(\log(70K) - x_i^K \gamma), \quad \text{and} \\
P(\hat{y}_i^K = 4 | x_i^K) &= 1 - \Phi_{\sigma_\eta}(\log(140K) - x_i^K \gamma | x_i^K).
\end{aligned}$$

Φ_{σ_η} is the normal CDF with mean zero and standard deviation σ_η. To estimate Equation (40), I use data on respondents' children from the HRS 1998-2010. I use children aged between 21 and 60. The results of the estimation are reported in Table B.1. I use these estimates, $\hat{\gamma}$, to construct the deterministic child income function in Equation (4).

Table B.1: Child Family Income Estimates

	Estimate
Constant	8.3439
Age	0.0607
Age^2	-0.0006
Home	0.4090
Female	0.3114
Female×Married	0.5835
Male×Married	0.3451
Work	0.8525
Work×Age	-0.0112
Work×Age^2	0.0000
Work×Female	-0.3655
Work×College	0.3393
Work×Female×Work$_{-1}$	0.2306
Work×Male×Work$_{-1}$	0.3667
σ_η	0.5002

Notes: The table reports estimated coefficients for the two-year child family income process.

C Additional Tables and Figures

Table C.1: Moments Generated with First-Stage Empirical Policy Functions

	Data	Empirical policy functions
LTCI purchase rate	0.14	0.13
Among parents with light LTC needs		
Light informal care rate	0.37	0.35
Intensive informal care rate	0.18	0.13
Paid home care rate	0.50	0.50
Nursing home rate	0.07	0.06
Among parents with severe LTC needs		
Light informal care rate	0.09	0.05
Intensive informal care rate	0.29	0.25
Paid home care rate	0.30	0.33
Nursing home rate	0.36	0.34
Child employment rate	0.66	0.67
Parent median consumption ($)		
Age 60s	37,540	33,696
Age 70s	34,837	32,322
Age 80s	33,128	29,506
Age 90s	31,797	25,108

Notes: The table shows empirical moments and simulated moments generated using the first-stage empirical policy functions of the CCP estimation. Informal care rates are among parents who have specified health statuses. Formal care rates are among parents who have specified health statuses and do not receive informal care from children.

Table C.2: Predictors for Beliefs about Children's Informal Care Provision

	Believe children will help	
Female	0.134***	(0.023)
Number of children	0.023***	(0.005)
Have a daughter	0.213***	(0.026)
Have a child living within 10 miles	0.220***	(0.018)
Age	0.007	(0.005)
Psychological condition	-0.059*	(0.025)
Diabetes	0.018	(0.027)
Lung disease	0.004	(0.032)
Arthritis	-0.028	(0.020)
Heart disease	-0.015	(0.028)
Cancer	0.089*	(0.035)
Bottom wealth quintile	-omitted-	
2nd wealth quintile	0.034	(0.023)
3rd wealth quintile	0.059*	(0.028)
4th wealth quintile	0.040	(0.031)
Top wealth quintile	0.022	(0.041)
Bottom income quintile	-omitted-	
2nd income quintile	-0.011	(0.029)
3rd income quintile	0.044	(0.029)
4th income quintile	0.017	(0.029)
Top income quintile	0.073*	(0.032)
Children's average education	-0.008	(0.006)
Children's average age	-0.003	(0.002)
Children's average home ownership	0.035	(0.027)
Children's average work status	-0.004	(0.030)
Observations	3,198	

Notes: $^{*}p < 0.05, ^{**}p < 0.01, ^{***}p < 0.001$. Standard errors are in parentheses. The dependent variable is an indicator for whether the individual believes children will help in the future with long-term care needs. The mean of the dependent variable is 0.55. Reported coefficients are the marginal effects from probit estimation. Not all coefficients are reported. The sample consists of individuals with children who are between ages 60-65 and do not have rejection conditions based on underwriting guidelines in Hendren (2013).

Table C.3: LTCI Equilibria under Gender-Based Pricing

Gender	Share	Annual premium ($)	LTCI coverage rate
Male	0.43	4,733	0.18
Female	0.57	6,906	0.07

Notes: The table reports the equilibrium of each insurance market segment when prices are conditional on the gender of a consumer.

Table C.4: LTCI Equilibria under Child Demographic-Based Pricing 1

(Daughter,	4+ children)	Share	Annual premium ($)	LTCI coverage rate
Yes	Yes	0.24	3,982	0.10
Yes	No	0.33	5,057	0.13
No	Yes	0.17	5,591	0.10
No	No	0.26	6,900	0.14

Notes: The table reports the equilibrium of each insurance market segment when prices are conditional on whether the consumer has a daughter and four or more children.

Table C.5: LTCI Equilibria under Child Demographic-Based Pricing 2

(Daughter,	Live close,	4+ children)	Share	Annual premium ($)	LTCI coverage rate
Yes	Yes	Yes	0.13	2,145	0.14
Yes	No	Yes	0.11	5,297	0.10
No	Yes	Yes	0.09	4,919	0.09
No	No	Yes	0.08	6,048	0.11
Yes	Yes	No	0.15	2,325	0.20
Yes	No	No	0.18	6,312	0.13
No	Yes	No	0.12	6,126	0.09
No	No	No	0.14	7,164	0.20

Notes: The table reports the equilibrium of each insurance market segment when prices are conditional on whether the consumer has a daughter, a child living in a 10 mile radius, and four or more children.