Nursing Homes in Equilibrium: Implications for Long-term Care Policies*

Tatyana Koreshkova
Concordia University and CIREQ
tatyana.koreshkova@concordia.ca

Minjoon Lee
Carleton University
minjoon.lee@carleton.ca

January 2021

Abstract

We build an equilibrium model of a nursing home market with decision-makers on both sides of the market. On the demand side, heterogeneous households with stochastic needs for long-term care solve dynamic optimization problems, choosing between in-home and nursing-home care. On the supply side, locally competitive nursing homes decide prices and intensities of care given the household demand. The government subsidizes long-term care of the poorest. The quantitative model successfully generates key empirical patterns. Evaluation of long-term care policies shows that the equilibrium approach is important for the welfare and distributional effects of policies targeting either side of the market.

Keywords: Long-term Care, Nursing Home, Medicaid.

JEL Classification numbers: D15, E21, I11, I13

*We thank the seminar and workshop participants at Concordia University, the Michigan Retirement and Research Center Workshop, and the Retirement and Savings Institute at HEC Montreal. The research reported herein was performed pursuant to a grant from the U.S. Social Security Administration (SSA) funded as part of the Retirement and Disability Research Consortium through the Michigan Retirement and Disability Research Center Award RDR18000002-02. The opinions and conclusions expressed are solely those of the authors and do not represent the opinions or policy of SSA or any agency of the Federal Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of the contents of this report. Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply endorsement, recommendation or favoring by the United States Government or any agency thereof. The research was also supported by the Social Sciences and Humanities Research Council.

1 Introduction

One of the big triumphs of the last century is the greatly increased human life expectancy. Growing old, however, is often accompanied by the accumulation of difficulties with activities of daily living,[1] requiring years of nursing home care or home-and-community-based care (in-home care, henceforth). As many seniors cannot afford the high cost of long-term care, the U.S. government instituted a set of policies that allow the care to be delivered to the poorest. The goal of this paper is to understand how the government intervention affects the nursing home market—the decisions of both care providers and care recipients—and assess the welfare effects of such policies.

The demand for long-term care is high: According to the recent estimates by the U.S. Department of Health and Human Services (2020), about 70 percent of Americans over the age of 65 develop severe needs for long-term care (LTC) and about half receive paid care over their lifetime. Hurd et al. (2014) find that over half of individuals will end up using nursing home care after age 50. Long-term care is expensive: According to Genworth (2019), the annual cost of a nursing home stay in 2019 is over \$100K for a private room and over \$90K for a semi-private room; in-home care costs between \$20 and \$40 per hour depending on the qualification of care providers and the type of care needed. The high out-of-pocket costs force a large share of Americans to rely on public long-term services and supports (LTSS) programs, most importantly Medicaid.[2] This spending further exacerbates the financial burden of public old-age programs, already strained by population aging. In this paper, we argue that the effects of public LTSS policies go beyond the budgetary and consumer insurance implications: They have non-trivial effects on the nursing home market, which, in turn, affect the allocation of care and distribution of welfare gains and losses from the LTSS policies.

We build a dynamic structural model of a nursing home market with the objective to quantitatively evaluate LTSS policies. In our model, demand and supply of nursing home care arise as a result of decision-making by optimizing agents. On the demand side, households, heterogeneous in age, financial resources, health, and family status, make consumption-savings decisions, and those with LTC needs choose to receive care, either at a nursing home or in their own home. On the supply side, locally competitive nursing homes decide price and intensity of care, taking as given the demand from the households.[3] Medicaid LTSS

[1] These include activities such as eating, toileting, dressing, bathing, getting in and out of bed, etc.

[2] According to Kaiser Family Foundation (2017), in 2015, out of the total of 1.12 million nursing home residents, Medicaid payed for 700 thousand individuals, or 62%, and for about as many individuals using in-home care, footing a \$72 billion-bill for senior long-term care.

[3] We define the care intensity as the number of care hours patients receive. See Section 2 for how we

policy imposes rules on both sides of the market. On the demand side, it determines eligible individuals through means tests and allows them to receive a certain amount of LTSS for free either at home or in a nursing home. On the supply side, Medicaid reimburses nursing homes at a fixed rate. We show that Medicaid policies targeting either side of the market have important consequences for both households and nursing homes, with non-trivial equilibrium effects on nursing home prices, quality, allocation of care and welfare.

On the demand side, we solve stochastic dynamic problems of retired households. Households face uncertainty about their health, which determines their LTC need, own and spouse survival, and, for those with children, child proximity. In contrast to most of the literature on old-age decisions and risks (Kopecky and Koreshkova, 2014 and Achou, 2016, among others), we endogenize both extensive and intensive margins of long-term care by modeling nursing home entry and in-home care intensity decisions. Each period, individuals with LTC needs choose between nursing home care and in-home care. While nursing homes provide fixed intensity of care, households can freely choose in-home care intensity. Although nursing home care is not flexible, the institutional setting allows nursing homes to provide care at a potentially lower unit cost compared to the in-home care. The out-of-pocket cost of in-home care differs across the households: It is relatively low for those with family support from the non-LTC spouse or a nearby child, and it is high for those without family support. Moreover, individuals without family face a substantial fixed cost when using in-home care to outsource basic home production. Poor households eligible for Medicaid decide whether to use Medicaid LTSS (for either nursing-home care or in-home care), which puts restrictions on resources to be kept, or pay for the in-home care out of pocket. The individual choice of care gives rise to the aggregate demand for nursing home care, which consists of the private demand and the demand by Medicaid enrollees. While both demands increase with the intensity of care, the price matters only for the private demand.

On the supply side, we solve a static problem of a nursing home competing in the local market with other nursing homes. Each nursing home faces an identical cost structure: a fixed cost of operation and a variable cost of providing care that depends on the number of beds and intensity of care—a public good within the facility. A nursing home decides the out-of-pocket price of bed and intensity of care so as to maximize its profits, taking as given the household demand for care, the reimbursement rate for Medicaid beds (set below the out-of-pocket price) as well as prices and care intensity of the competitors. Lower price attracts private residents while higher intensity attracts both private and Medicaid residents. In general, a nursing home cannot refuse entry to an eligible Medicaid resident. A nursing

measure care intensity from the data. We prefer the term 'intensity' to 'quality' as for in-home care patients, small numbers of care hours used reflect their low demand for care.

home is also not allowed to discriminate on either care intensity or price. Therefore, marginal profits on Medicaid beds play an important role in determining the total number of beds, their allocation between Medicaid and out-of-pocket residents, and the intensity of care. We solve for the symmetric Nash equilibrium of the nursing home market. Although the profit margin on the private bed exceeds that on the Medicaid bed, the relative elasticities of the private demand versus Medicaid demand matter when deciding the optimal quantity and allocation of beds.

We discipline the demand-side parameters of the model with micro-evidence on the LTC usage patterns observed in the data. Using the Health and Retirement Study data, we document the type and intensity of care used conditional on age, financial resources, health, and family status. The model equilibrium successfully generates the documented care patterns, including those we do not target. Most importantly, individuals without family are more likely to reside in a nursing home, and the nursing home usage is U-shaped in wealth. The latter pattern arises because the high out-of-pocket cost of nursing home implies that it is used primarily by richer individuals or by poor whose long-term care costs are paid by Medicaid. The supply-side parameters target the key statistics for nursing homes such as the price and intensity of care, nursing home size, and the number of nursing homes in the local market.[4]

We use the quantitative model to evaluate the efficiency and distributional effects of four LTSS policies. Two of them target the supply side of the nursing home market: *(i)* a more generous Medicaid reimbursement of nursing home beds and *(ii)* a subsidized entry of a nursing home. The other two target the demand side: *(iii)* a more generous Medicaid means-test for single households and *(iv)* an in-home care subsidy for individuals with no family support. We show that in every case it is important to capture the impact of the policies on both sides of the market.

A higher Medicaid reimbursement rate increases the return on Medicaid beds, creating incentives to both reallocate beds and increase intensity of care in order to attract more Medicaid residents. We find that a 10% increase in the Medicaid reimbursement rate (from $76.5K to $84.2K per year) raises the intensity of care by 3% (64 hours per resident per year) and the out-of-pocket price by 2% ($1.9K per year). Although the higher price discourages some out-of-pocket residents, higher intensity mitigates this effect. In equilibrium, each nursing home gains 3.8 Medicaid residents and loses 0.6 out-of-pocket residents.[5] Nursing

[4]Our data source for the supply-side of the market is the Nursing Home Reports by the Pennsylvania Department of Health. Pennsylvania is one of the few states with consistent and accessible reporting of the state nursing home data and their market is fairly representative of the U.S.

[5]In the baseline model calibrated to match the average nursing home facility in Pennsylvania, the average size of a nursing home facility is 137 beds, with the average annual price of $85K per bed, and 2,000 annual

homes reap a large increase in profits while Medicaid suffers even a larger increase in its outlays. Households in the middle of the wealth distribution enjoy most of the small benefits from the higher intensity of nursing home care. Households in the top wealth quartile suffer small losses from the higher out-of-pocket price.[6]

A subsidized entry of a nursing home increases the competition on the local market. We find that incumbents react to the entry not only by reducing the price but also by reducing the intensity of care: Price falls by 10.7% ($4.1K per year) and intensity of care declines by 7.3% (155 hours per year). These nursing home decisions induce movements in and out of the institutional care. Wealthier individuals, benefiting from the lower price and a larger choice of facilities, leave the out-of-pocket in-home care for nursing homes. Individuals in the bottom half of the wealth distribution, hurt by the lower intensity of nursing home care, free Medicaid beds in favor of Medicaid and out-of-pocket in-home care. This reallocation of care increases the number of out-of-pocket residents by 13.8% (4.3 beds per facility) and reduces the number of Medicaid beds by 18.4% (19.5 beds per facility), which ends up decreasing the total number of Medicaid nursing home residents even though there are more nursing homes available.

We then consider a more generous Medicaid policy on the demand side for single seniors. While under the current Medicaid rules single individuals are virtually not allowed to keep any wealth to qualify for Medicaid, we introduce a wealth exemption of $10,000. We find that nursing homes react to the larger pool of single Medicaid enrollees with higher intensity of care (6.7% or 134 hours per year), which further stimulates the demand for Medicaid beds: They increase by 34.5% or 36.6 beds per facility. However, the 12.9% higher price of bed discourages out-of-pockets residents from staying in nursing homes, reducing their number by 22.1% or 6.9 residents per facility. Although consumers across the wealth distribution benefit from this policy—with the largest gains enjoyed by the middle two quartiles—the increase in the Medicaid outlays exceeds the increase in the consumer surplus nearly by a factor of two, while nursing homes experience a small loss.

In our last policy experiment we introduce a $10K subsidy to the in-home care for individuals with no family support that allows them to cover half of the fixed in-home care cost. We find that all players—consumers, producers, and government—benefit from this policy. As private residents with no family support leave nursing home for cheaper out-of-pocket in-home care, the nursing homes react by reducing both the price (-4.5% or $3.9K per year) and the intensity of care (-7.7% or 155 hours per year). Lower intensity of care makes nursing

hours of care per resident.

[6] The welfare changes of households are calculated as one-time wealth transfers that need to be made to the youngest households (age 70) in the baseline model to give them the same utility as with the policy experiment.

home less valuable to Medicaid enrollees; as a result, 12.8% of Medicaid residents (3.6 per facility) leave their free nursing home beds. We find that more than half of them switch to the out-of-pocket in-home care, reducing the Medicaid outlays by 2.7% or $2.7M per year. Even though nursing homes lose 12% of their residents, their profits are almost unaffected due to cost savings. Consumers across the entire wealth distribution benefit from the policy, with gains increasing in wealth.

We find that in all of the above policy experiments the reactions of both sides of the market are important for accurately assessing the aggregate and distributional impact of each policy and even more so for evaluating policy efficiency. To our knowledge, this is the first paper to incorporate both a micro-founded demand for nursing home care and competitive nursing homes into an equilibrium model. The analysis that comes closest in spirit to ours is by Hackmann (2019), who structurally estimates an equilibrium model of nursing home market but with a reduced-form demand for nursing home care.

This paper builds on important existing works on the LTSS policy. Among the studies focusing on the supply side, Nyman (1985), Gertler (1989), Grabowski (2001), and Hackmann (2019) study the effects of an increase in the Medicaid reimbursement rate; Ching et al. (2015) examines the role of the quantity restriction through the certificate-of-needs policy; Hackmann (2019) considers promoting more competition through an incentivized entry of a nursing home. Among the studies focusing on the demand side, De Nardi et al. (2016), Mommaerts (2018), and Achou (2020) study the role of Medicaid generosity for households; Ettner (1994) and Stabile et al. (2006) examine Medicaid home-care benefits.

To date, few models study equilibrium on the nursing home market. Ching et al. (2015) and Hackmann (2019) structurally estimate both the demand and supply curves of the market and run counterfactual experiments. Compared to these papers, our contribution is twofold. First, while those studies assume a fixed value for the in-home care utility, we explicitly model the trade-offs faced by the heterogeneous households when choosing among the LTC options, where the values of the options are affected by the LTSS policies. Second, in constrast to the static demand for care in those papers, we solve stochastic dynamic optimization problems for the representative population of seniors in the U.S. This is important because LTSS policies affect saving decisions of households prior to the realization of their LTC needs, which in turn influences the characteristics and decisions of LTC consumers.

This paper also relates to the literature that studies the substitutability between nursing home care and in-home care, where the latter is often supported by help from family members. Papers that examine this substitutability empirically include Mommaerts (2016), Mommaerts (2018), and Barczyk and Kredler (2019). Barczyk and Kredler (2018) proposes a structural model that captures the strategic motives behind family caregiving. Mommaerts

(2016) and Ko (2020) study the implication of this substitutability on the long-term care insurance demand. Our work contributes to this literature by examining the implications of the substitutability between nursing home care and in-home care on the effects of LTSS policies, where the value of the nursing home option is endogenously determined by nursing home decisions.

Lastly, this paper also connects to the literature that uses structural models to study old-age risks and decisions, such as precautionary savings (e.g., De Nardi et al., 2010; Ameriks et al., 2011; Kopecky and Koreshkova, 2014; Ameriks et al., forthcoming) and demand for public and private LTC insurance (e.g., Brown and Finkelstein, 2008; Ameriks et al., 2018; Braun et al., 2019). Our model augments a standard life-cycle model used in this literature with explicit modeling of LTC decisions, both on the extensive margin (the type of care used) and on the intensive margin (the intensity of care received at home). We also extend the standard models by incorporating the interactions between the demand and supply of long-term care.

The structure of the rest of the paper is as follows. In Section 2, we show the empirical patterns of LTC demand and supply that guide our modeling of both sides of the market. Section 3 presents a stylized, static model of the LTC market to illustrate the main mechanisms at work. Section 4 builds a full-fledged structural model of the LTC market, and Section 5 discusses the parameterization of the model. Section 6 shows the outcomes of four LTSS policy experiments. Section 7 concludes.

2 Empirical Patterns of Long-term Care Demand and Supply

In this section, we examine the empirical patterns of LTC demand and supply. Heterogeneity of LTC demand over age, health, family status, and financial resources motivate our structural model of LTC choice. Key empirical facts regarding nursing homes help discipline the supply side of our model.

2.1 Demand

We use the Health and Retirement Study (HRS) data, a biennial survey of a representative sample of the U.S. population over age 50, to examine the empirical patterns of LTC demand. We analyze both the extensive margin—which households are more likely to use nursing homes versus in-home care—as well as the intensive margin—the number of care hours they use—of LTC choice. We consider the number of care hours used as the measure of the "intensity" of long-term care in this paper. We use pooled data from waves 2004-2014, where we can find consistent questions in particular on the number of hours of care respondents receive when they need help with the activities of daily living (ADLs). We use the sample of respondents in their 80s.[7]

We define the health status of individuals based on how many ADLs they need help with. We classify those who need help with more than three ADLs out of five ADLs–eating, bathing, dressing, walking across a room, and getting in or out of bed—as being in "high needs of help with ADLs" (ADLH); those who need help with one or two ADLs are classified as "low needs of help with ADLs" (ADLL). For the type of care used, individuals who receive help with ADLs outside of a nursing home are considered to be using in-home care. Lastly, for the number of care hours used, in the in-home care case, we sum the number from each helper listed in the HRS; in the nursing home case, we record it as 2,000 hours per year following the literature (e.g., Mommaerts, 2016).

Own health and availability of family support matter significantly for the choice of care type as well as the intensity of care. Panel A of Table 1 shows that, not surprisingly, those who need help with more ADLs receive a larger number of care hours. The care hours under ADLH is three times larger than under ADLL at the median; the mean is twice larger. Own health also affects the type of care used. Nursing homes typically do not provide much flexibility in the care set up. Their set up is mostly calibrated for those needing relatively intensive care, which is not an attractive option for those who can manage to do three or more ADLs on their own. Hence, the vast majority use in-home care under ADLL, while about one-third enter a nursing home under ADLH.

Table 1: LTC demand over health and family status

	Care hours used					
	25p	50p	75p	Mean	nursing-home (%)	N
A. Health						
ADLH	1,188	2,000	3,720	2,574	31	1,723
ADLL	288	744	2,000	1,355	11	1,205
B. Family status (conditional on being ADLH)						
With family support	1,116	2,000	4,320	2,723	27	1,409
Without family support	900	2,000	2,000	2,042	51	314

Note: Hours is the number of care hours received per year. Being in a nursing home is coded as 2,000 hours per year. Individuals who have a living spouse who does not need help with ADLs or have a child within 10 miles is considered as to have family support.

Conditional on own health, availability of family support also affects individuals' choices.

[7] Needing LTC is less prevalent below age 80; The number of observations is too small above age 90.

We classify those with (i) a living spouse who does not need help with ADLs or (ii) a child within 10 miles as "with family support."[8] Panel B of Table 1 tabulates the LTC demand patterns by family status, conditional on being under ADLH.[9] The choice of the type of care used strongly depends on the availability of family support: While individuals with family support predominantly choose the in-home care, those without family support are equally likely to use either nursing home or in-home care. The average number of care hours is larger with family support, which is particularly driven by the fat right tail of the distribution. For those without family support, the distribution is bunched at 2,000 hours, which is the imputed value for the nursing home care.

Financial resources also affect the LTC demand patterns though its effect is smaller than that of family support. Table 2 shows the share of those using nursing-home care conditional on income and wealth quartiles, family support, and being under ADLH. The impact of financial resources is noticeable: The share of nursing-home care has a U-shape over income and wealth. This shows that the use of in-home care is most common among individuals who are not eligible for Medicaid but find the out-of-pocket nursing home cost too high. These individuals end up receiving significantly less care than 2,000 hours per year.

Table 2: Share of nursing-home care (%): over wealth and income

	Wealth quartiles				Income quartiles			
Family structure	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Without family support	65	34	26	45	53	50	48	51
With family support	33	24	18	21	26	28	27	23

Note: This table tabulates the demand patterns conditional on being under ADLH. N=314 for those without family support; N=1,409 for those with family support. Also see notes for Table 1.

In the HRS data, the share of Medicaid enrollees among the individuals under ADLH is 27%. Taking into account Medicaid program participation is under-reported by 31.4% (Miller et al., 2020), we estimate the Medicaid rate to be 39.2%. For the Medicaid enrollees, in-home care and nursing home are equally likely options—the share of in-home care among Medicaid enrollees is 49%.

In the model we develop, we try to capture the key patterns presented. A much higher share of in-home care among those with family support means that the effective cost of using

[8] We found that having a child but not within 10 miles does not have much impact on the LTC demand patterns.

[9] We focus on the demand conditional on ADLH from this point, as there is not much variation in the type of care used under ADLL as Panel A shows. We do, however, make sure that the demand patterns from our model match the empirical patterns conditional on ADLL as well.

in-home care is much lower for them (mostly reflecting informal care provided by family members). In our model, individuals without family support face a trade-off between the flexibility of in-home care and the cheaper cost of care (per hour) received at a nursing home. The U-shape of the share of nursing-home care over financial resources will be generated as an outcome of this trade-off.

2.2 Supply

To obtain basic facts regarding local competitions in the nursing home market, we use the Nursing Home Reports by the Pennsylvania Department of Health that cover the universe of nursing homes in Pennsylvania.[10] We also use some moments reported in Hackmann (2019) that are also from the nursing homes in Pennsylvania.[11]

Hackmann (2019) reports that 90 percent of nursing home entrants travel less than 23 kilometers (approximately 15 miles) to find a nursing home. Based on this, we set the size of one nursing home market to be 700 square miles (the size of a circle with a radius of 15 miles). According to the Nursing Home Reports data, there are, on average, 11 nursing homes per each nursing home market. Using Census data, we also find that there are 24,000 people that are 70 years or older per nursing home market. Our quantitative model represents one nursing home market, and hence we set the number of nursing homes and the size of the elderly population to match these facts. There are 90,000 beds in total in all 700 nursing homes in Pennsylvania, so on average, each nursing home has about 130 beds. This number is not explicitly targeted in our model, but we check that the average size of nursing homes in our model matches this number.

According to the Nursing Home Reports, the average out-of-pocket costs of using a semi-private room in a nursing home is about $85,000 per year.[12] Note that a nursing home provides not only health and personal care but also other amenities, including a room, food, cleaning service, etc.[13] Considering this, and also that the per-hour cost of intensive in-home care is about $35 (Mommaerts, 2016, Genworth, 2019), a nursing home is a cheaper option

[10] We use the data from 2017. The data can be accessed through the following link: https://www.health.pa.gov/topics/HealthStatistics/HealthFacilities/NursingHomeReports/Pages/nursing-home-reports.aspx.

[11] Online Appendix A in Hackmann (2019) reports that the nursing home market in Pennsylvania is fairly representative of the U.S. nursing home market, in terms of size and compositions of nursing homes as well as characteristics of the nursing home residents. One aspect of the nursing home market that varies significantly across states is whether there is a size restriction on nursing homes based on the Certificate-of-Needs law. While two thirds of the U.S. states have it, in many states the restriction is not binding. Pennsylvania is among the states that do not have this restriction, so we abstract from it in this analysis.

[12] This paper uses 2017 dollars.

[13] Hackmann (2019) reports that the non-health-related resident cost is about one-third of the health-related cost.

for those who demand intensive long-term care but do not have family support, as they also need to outsource basic home production.[14] This reflects that nursing homes can provide intensive care at a lower unit cost compared to in-home care, which is made possible by institutional setup and standardization of the care at a nursing home. Our model captures this feature as increasing returns to scale over the intensity of care in the nursing home cost function.

Hackmann (2019) documents that the Medicaid reimbursement rate is about $76,500, which is 10 percent lower than the out-of-pocket price from the Nursing Home Reports. He also reports that the average fixed cost of operating a nursing home is about $1.3 million per year. Our quantitative model will generate the observed out-of-pocket price as the optimal price chosen by nursing homes facing the documented Medicaid reimbursement rate. Each nursing home in our model will have profits enough to cover the fixed costs of operation but not too much to allow for a profitable entry of an additional nursing home.

3 A Static Model of the Market for Long-term Care

In this section, we propose a simple model of the nursing home market, featuring optimizing consumers and producers, with a purpose of establishing intuition for the large quantitative model presented in the next section. Starting with the demand side, we characterize the demands for nursing home care: The private demand and the demand of Medicaid enrollees' (hereafter "Medicaid nursing home demand"). Then we examine the nursing home decisions given the demands for care and highlight the role of Medicaid in the incentives on both sides of the market.

Consider a closed community of individuals who need long-term care. They can obtain this care either at home (in-home care) or by moving to a nursing home. The two types of care differ in flexibility and prices, taken as given by an individual. While the intensity of care received at home is flexible and decided by an individual, a nursing home provides a uniform intensity to all residents. Individuals in a community are heterogeneous in wealth and the effective price of in-home care. The latter is intended to capture the availability of informal care by family members.

In this section we assume that there is a single nursing home operated by a monopolist. The monopolist observes the distribution of individuals and their Medicaid eligibility and perfectly predicts the aggregate demand when deciding the price and intensity of care.

[14] See Section 5 for more details of the cost comparisons across different LTC options.

3.1 The Demand Side

Individual preferences are defined over consumption of care services q^k of type $k \in \{H, N\}$, where H denotes in-home care and N denotes nursing-home care, and non-care goods c:

$$U^k = u(q^k) + v(c),$$

where $u(.)$ and $v(.)$ are increasing, continuous, twice continuously differentiable, concave, and satisfy the Inada conditions. For expositional purposes in this section, we assume that preferences are also homothetic. Individual resources consist of wealth ω and government transfers TR^k for care k, which are allocated between expenditures on care, LTC^k, and non-care goods:

$$LTC^k + c = \omega + TR^k.$$

The cost of q hours of in-home care at a price ρ per hour is $LTC^H = \rho q$, and the cost of a nursing home stay, which comes with fixed intensity Q, is $LTC^N = P$.

We first examine the care decision in the absence of public assistance for long-term care ($TR^k = 0$, $\forall k$). The optimal intensity of out-of-pocket in-home care, q, satisfies the first-order condition:

$$u'(q) = \rho v'(\omega - \rho q). \tag{1}$$

Utility attained under in-home care determines the reservation utility for a potential nursing home entrant:

$$U^H(\omega, \rho) \equiv u(q) + v(\omega - \rho q). \tag{2}$$

Both the optimal out-of-pocket in-home care and the reservation utility are increasing in wealth and declining in the price of in-home care.

3.1.1 Private Demand for Nursing Home Care

Taking as given the intensity of nursing home care, Q, and the price of bed, P, an individual chooses nursing home care if the utility attained in a nursing home exceeds her reservation utility:

$$U^N(\omega, P, Q) = u(Q) + v(\omega - P) \geq U^H(\omega, \rho). \tag{3}$$

For each individual wealth level ω, the participation constraint (3) determines the reservation level of nursing home intensity $\mathcal{Q}(\omega, P, \rho)$, such that for $Q > \mathcal{Q}(\omega, P, \rho)$ the individual strictly prefers nursing home and for $Q < \mathcal{Q}(\omega, P, \rho)$—in-home care. Our quantitative model will consider two types of individuals, with and without family support. Individuals with family support— those who have either able spouses and/or a child nearby— face a lower price of in-home care compared to a single individual without a child living nearby: $\rho_F < \rho_S$. On Figure 1a, optimal in-home care allocations of these individuals are indicated by points F and S. The indifference curves passing through those points correspond to their participation constraints (3). Any nursing home intensity-price combination that delivers a point above the indifference curve is accepted. A nursing home charging price P would have to deliver at least Q_S for the single individual, and at least Q_F for the one with family. A nursing home with the intensity-price offer associated with point N is accepted by the single individual but not by the individual with family.

The marginal individuals—those with binding participation constraints, $Q = \mathcal{Q}(\omega, P, \rho)$—determine the demand schedule faced by the nursing home. Hence properties of the demand for nursing home care can be derived from the properties of the reservation intensity function.

Proposition 1: *The reservation intensity $\mathcal{Q}(\omega, P, \rho)$ is U-shaped in wealth, increasing in the price of the nursing home and declining in the price of in-home care.*
Proof: See Appendix B.1.

Figure 1: Extensive margins of demand

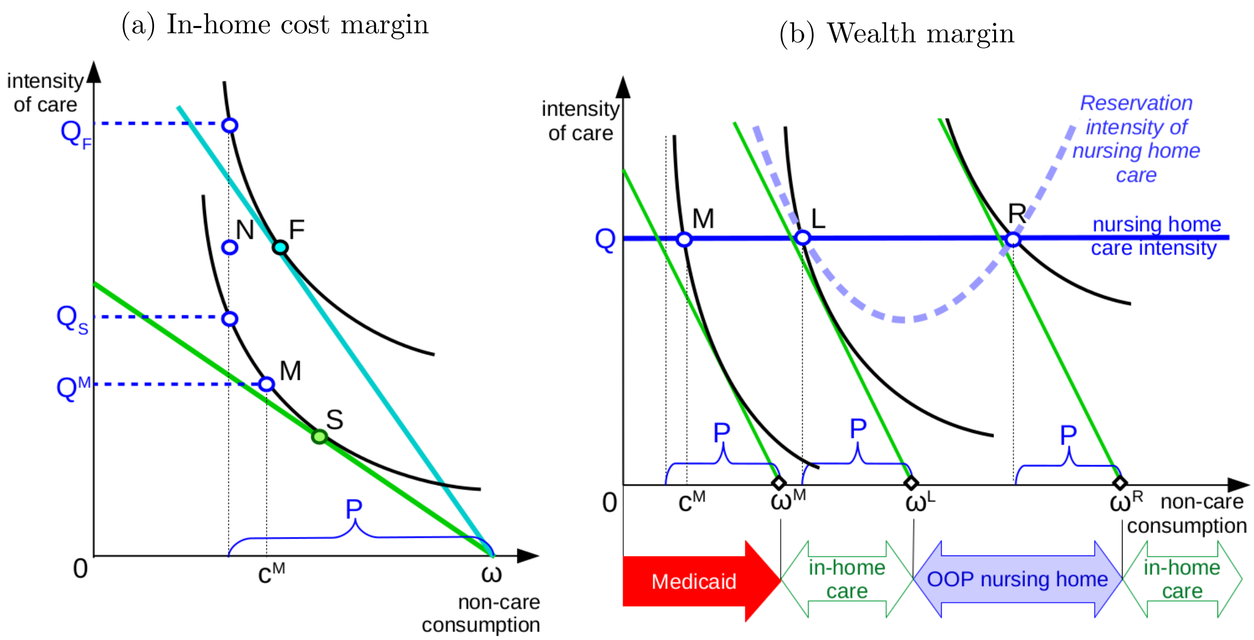


Figure 1b illustrates the implications of the Proposition 1 in a community of individuals facing the same price of in-home care which is higher than the unit price of nursing home care (e.g., single individuals without family support).[15] The marginal individual with wealth ω^L is indifferent between a nursing home with intensity Q (point L) at price P and a less intensive in-home care. Although the price of the in-home care exceeds the unit price of the nursing home care, what matters is the shadow price of the nursing home care, given by the marginal utility of the non-care consumption and reflected in the slope of the indifference curve at point L. It is in this sense that the inflexibility of the nursing home care effectively makes it too expensive (the shadow price is too high) for the individuals with wealth $\omega < \omega^L$. The marginal individual with wealth ω^R is also indifferent between the nursing home (point R) and a more intensive in-home care. Although the richer marginal individual faces a lower shadow price of the nursing home care, her demand for care is high. The inflexibility of the nursing home care implies that richer individuals (with wealth $\omega > \omega^R$) find that nursing home provides insufficient intensity. Individuals with wealth in-between the two cut-offs strictly prefer nursing home care. Thus, in-home care is chosen by poorer individuals for whom nursing home is effectively too expensive and who have to make do with little care, as well as by richer individuals, who demand higher intensity of care. Moreover, higher nursing home intensity, achieved by raising the blue line on Figure 1b, would attract more residents at both ends of the wealth spectrum (see Appendix B.1 for details).

Let the distribution of individuals be continuous over the support $\omega \in [\underline{\omega}, \bar{\omega}]$ with cdf $\Phi_i(\omega)$ and a continuous positive pdf $\phi_i(\omega)$, $i \in \{S, F\}$. Let ψ_i be the share of individuals with the in-home care price ρ_i. Given these assumptions and Proposition 1, the following proposition formally states the private demand for nursing home and characterizes its properties.

Proposition 2. *The private demand for nursing home care by individuals of type $i \in \{S, F\}$ can be written as follows:*

$$n_i(P, Q) = \psi_i \left[\Phi_i(\hat{\omega}_i) - \Phi_i(\breve{\omega}_i)\right], \tag{4}$$

where wealth levels of the marginal individuals, $\{\hat{\omega}_i, \breve{\omega}_i\}$, solve (3) at equality for each (P, Q, ρ_i), such that $\breve{\omega}_i \leq \hat{\omega}_i$. The demand has standard properties: It decreases in price, and increases in intensity and the price of in-home care: $\frac{\partial n_i}{\partial P} < 0$, $\frac{\partial n_i}{\partial Q} > 0$, and $\frac{\partial n_i}{\partial \rho_i} > 0$.
Proof: See Appendix B.2.

Figure 2a shows the allocation of care in the space of wealth and the price of in-home care. Nursing home is chosen by individuals in the middle wealth range and the price of

[15] The role of Medicaid, which is also described in this figure, is introduced in the next subsection.

in-home care exceeding the unit price of nursing home care: $\rho > \frac{P}{Q}$.[16]

3.1.2 Nursing Home Demand with Medicaid

Consider a Medicaid LTSS policy that pays for a nursing home of given intensity Q and provides an individual with consumption floor c^M.[17] We assume that the policy pays for the same amount of the in-home care. For expositional purposes in this section, we also set the same consumption floor for the Medicaid in-home care recepients, making a Medicaid enrollee indifferent between the nursing home and in-home care. Without loss of generality, here we allocate such individuals to the nursing home care.

To enroll in the Medicaid LTSS program, an individual must require long-term care and his resources must be insufficient to achieve the consumption floor on his own under nursing home care. Those who receive Medicaid transfers cannot keep any wealth.

An individual chooses among three options: in-home care ($k = H$), out-of-pocket nursing home care ($k = N$), and Medicaid nursing home ($k = M$):

$$\max \left\{ U^H(\omega, \rho), U^N(\omega, P, Q), U^M(c^M, Q) \right\}, \tag{5}$$

where $U^M(c^M, Q) = u(Q) + v(c^M)$.

Conditional on using the nursing home, the choice between the Medicaid and OOP option is trivial: Medicaid is preferred if $\omega < c^M + P$. The most relevant trade-off here is between the in-home care, which has an advantage of flexible care intensity and consumption, and the Medicaid nursing home, which requires giving up all wealth and delivers fixed levels of care intensity and consumption. Figure 1a shows a single individual who is indifferent between the Medicaid nursing home (point M) and the OOP in-home care (point S). Q^M is the minimum level of nursing home care that makes Medicaid consumption c^M an attractive option for this individual. The individual with family and, hence, lower price of the in-home care, would require a much higher intensity of care for Medicaid option to be beneficial. Point M on Figure 1b indicates the same marginal individual: Individuals with wealth levels below ω^M strictly prefer Medicaid nursing home while his richer neighbors prefer the in-home care.

Figure 1b maps the choice of care across the wealth distribution given the price of the

[16]In the quantitative model, we allow for preference shocks that introduce a random component to the choice of care so that some individuals with low price of in-home care prefer nursing home care.

[17]This set up differs from the quantitative model which features fixed consumption value of nursing home. The discrepancy is due to the static versus dynamic setup and for the ease of exposition: In the static model, we abstract from the consumption value of nursing home and interpret consumption of private residents as capturing the bequest value of their wealth. To be able to examine effects of generosity of Medicaid in the static model, c^M has to be one of the Medicaid policy parameters.

in-home care. There are 4 distinct regions: Nursing home is used by the poor individuals with the help of Medicaid and by a set of relatively well-off individuals paying out of pocket, while the rest choose the out-of-pocket in-home care. This allocation of care gives rise to the U-shaped pattern of the nursing home care utilization in our quantitative model.

Figure 2a shows the allocation of care in the space of in-home care price and wealth, given the intensity and price of nursing home, as well as the consumption value of the Medicaid nursing home. Consider two levels of the in-home care prices: $\rho_F < \frac{P}{Q}$ (with family) and $\rho_S > \frac{P}{Q}$ (single, without family). For singles, poor individuals rely on Medicaid, middle-income individuals choose the OOP nursing home and the rest use the in-home care. For individuals with family, poor use Medicaid nursing home, and the rest use a relatively cheap in-home care. For the rest of this subsection, we focus on these two types of individuals, with wealth levels such that the marginal tradeoff is between the Medicaid nursing home and the in-home care, i.e., $\omega < c^M + P$.

As the utility of the Medicaid nursing home stay increases, either due to a higher care intensity or higher Medicaid consumption floor, the Medicaid option becomes attractive to individuals with more resources at each in-home care price. Figure 2b shows the overall increase in demand for the Medicaid nursing home due to a higher consumption floor, and a similar effect occurs due to a higher intensity of the nursing home care (Figure 2c). However, as discussed in Section 3.1.1, higher nursing home intensity also expands the pool of the out-of-pocket residents by drawing them from the in-home care pool on both side of the wealth spectrum. Finally, an increase in the price of nursing home bed has the opposite effect on the private demand for nursing home, but has no effect on the frontier separating the Medicaid nursing home residents and the out-of-pocket in-home care recipients (Figure 2d).

Given the assumptions on the distribution of agents made in Section 3.1.1, the following propositions formally state the Medicaid demand for nursing home care and summarize its properties.

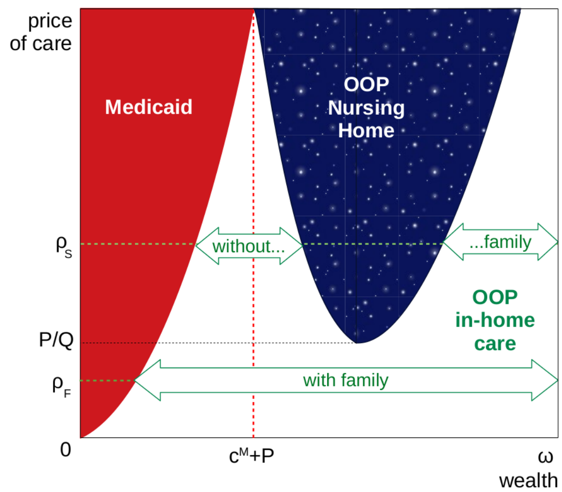
Proposition 3. *The Medicaid demand for nursing home care by individuals of type $i \in \{F, S\}$ can be stated as*

$$m_i(Q|c^M) = \psi_i \Phi_i[\omega^M(Q|c^M, \rho_i)], \tag{6}$$

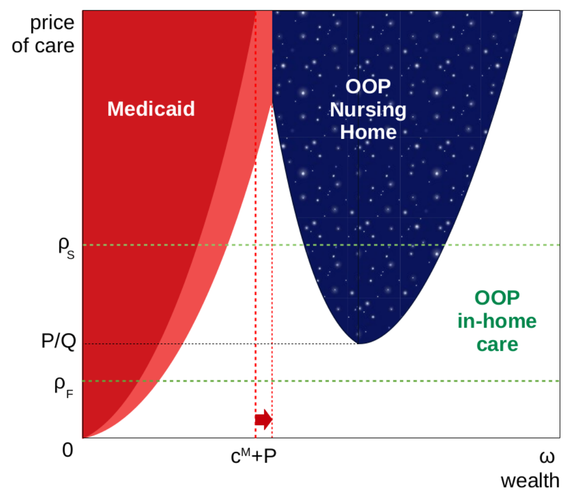
where $\omega^M(Q|c^M, \rho_i) < C^M + P$ is the wealth of the marginal individual of type i who is indifferent between the out-of-pocket in-home care and the Medicaid nursing home, with $\omega^M(Q|c^M, \rho_F) < \omega^M(Q|c^M, \rho_S)$. The Medicaid demand for nursing home care by individuals of type $i \in \{F, S\}$ has the following properties:

Figure 2: Effects of changes in Medicaid eligibility, Medicaid consumption, and price of nursing home on the demand for care

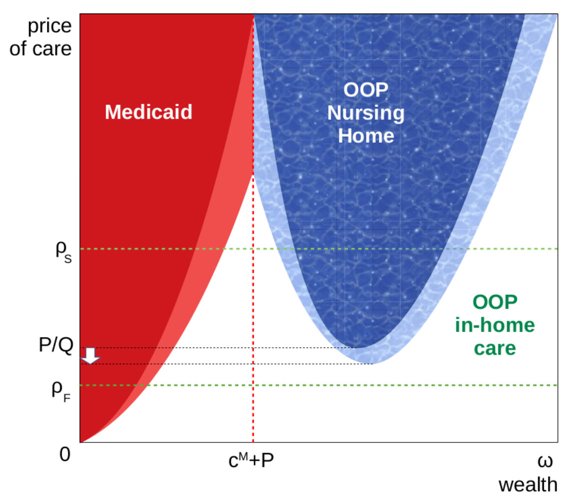
(a) With Medicaid



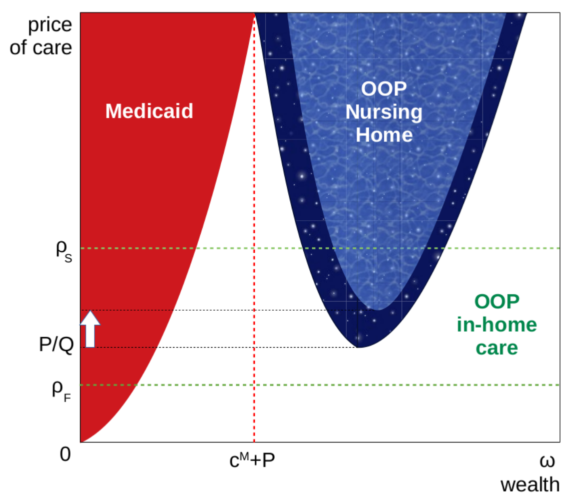
(b) More generous Medicaid (increase in c^M)



(c) Higher intensity of nursing home (Q)



(d) Higher price of nursing home (P)



1. *The slope of the demand over intensity is positive:* $\frac{\partial m_i}{\partial Q} \geq 0$.

2. *The demand is increasing in the Medicaid generosity (consumption floor):* $\frac{\partial m_i}{\partial c^M} > 0$.

3. *The slope of the demand over intensity increases with the Medicaid generosity if the wealth density is either increasing at* ω^M *or does not decline too fast:* $\frac{\partial^2 m_i}{\partial Q \partial c^M} > 0$ *if* $\phi'(\omega^M) \geq -\epsilon$ *where* ϵ *is sufficiently small.*

Proof: See Appendix B.3.

These properties will be relevant when discussing effects of the Medicaid generosity on the nursing home decisions. To sum up, the aggregate demand for nursing home care consists of private payers' demand and Medicaid enrollees' demand. Private payers are individuals in the middle range of the wealth distribution, for whom intensity of the nursing home care is close to what they would have chosen under the out-of-pocket in-home care. Medicaid allows poor individuals, who are priced out of nursing home care, to achieve higher levels of care relative to the out-of-pocket in-home care. While the number of private residents can be controlled with both price and intensity of the nursing home care, the Medicaid demand only responds to the latter.

3.2 The Supply Side

3.2.1 Nursing Home Problem

We now consider the decisions of a monopolistic nursing home that takes as given the demand for beds studied above. The nursing home chooses the price and intensity of care. We assume that intensity of care is a public good: The nursing home cannot discriminate among the residents on intensity. We also rule out price discrimination. Although the nursing home cannot deny a bed to a Medicaid resident, it can still control the Medicaid demand for its beds by varying the intensity of care. The nursing home takes as given the reimbursement rate, $M < P$, set and paid by Medicaid, and in this sense, it acts as a partial price-taker.[18]

The nursing home faces the cost schedule $\mathcal{C}(N, Q)$, where $N = n+m$ is the total number of beds, with the following properties: The marginal cost of bed $\mathcal{C}_N$ is increasing in the number of beds and intensity ($\mathcal{C}_{NN} > 0$, $\mathcal{C}_{NQ} > 0$) and the marginal cost of a unit of intensity (an hour of care) is non-increasing in the total intensity ($\mathcal{C}_{QQ} \leq 0$). These assumptions are consistent with nursing home capacity constraints and potential increasing returns to scale in intensity due to the centralized care provision.[19]

The nursing home chooses price and intensity taking as given aggregate private demand $n(P, Q) \equiv \sum_{i=S,F} n_i(P, Q|\rho_i)$ and aggregate Medicaid demand $m(Q|c^M) \equiv \sum_{i=S,F} m_i(Q|c^M, \rho_i)$:

$$\max_{P,Q} \quad Mm(Q|c^M) + Pn(P, Q) - \mathcal{C}(n(P, Q) + m(Q), Q). \tag{7}$$

The first-order conditions for price and intensity are:

[18] If servicing all qualifying residents implies negative profits, the nursing home does not operate.

[19] These assumptions are also consistent with the results of our parameterization procedure for the quantitative model, which does not pre-impose these conditions (see Section 5).

$$-(P-\mathcal{C}_N)\frac{\partial n}{\partial P} = n(P,Q), \tag{8}$$

$$(M-\mathcal{C}_N)\frac{\partial m}{\partial Q} + (P-\mathcal{C}_N)\frac{\partial n}{\partial Q} = \mathcal{C}_Q. \tag{9}$$

The terms in parentheses on the left-hand side of these equations correspond to profit margins: $(P-\mathcal{C}_N)$ is the marginal profit on a private bed and $(M-\mathcal{C}_N)$ is the marginal profit on a Medicaid bed, which we assume to be positive. Equation (8) ensures that, at the optimum, the benefit of increasing price by \$1 on each of n private residents (the right-hand side) equals the loss in profits due to the residents forgoing nursing home in favor of relatively cheaper in-home care (the left-hand side). Equation (9) weighs the cost of increasing intensity by 1 hour (the right-hand side) against the benefits—marginal profits generated by the additional demand for the nursing home care (the left-hand side) from both private and Medicaid residents attracted by the higher intensity.[20]

3.2.2 The Role of Medicaid

One of the main goals of this paper is to understand how Medicaid affects the nursing home market: intensity of care, price of bed, number of beds, distribution of residents, and overall welfare. Although assessing many of these effects requires a quantitative analysis, the purpose of this section is to highlight the channels underlying the nursing home's incentives as well as to identify unambiguous effects whenever possible.

In our analysis, Medicaid is characterised by two policy variables: the reimbursement rate M on the supply side and the consumption floor c^M on the demand side. We assume that nursing homes cannot reject an eligible Medicaid resident in favor of a private resident.

Suppose there exists a market equilibrium where the nursing home makes positive profits given Medicaid policy (M, c^M). Now consider a more generous Medicaid policy: first, on the supply side, then, on the demand side.

Medicaid generosity on the supply side Consider an increase in the Medicaid reimbursement rate M. The policy change directly increases the profit margin on a Medicaid bed on the left-hand side of (9). The higher return on Medicaid beds induces nursing home to supply higher intensity of care in order to attract more Medicaid residents. The higher care intensity, in turn, increases the private demand. Decreasing returns to the number of beds

[20] Without Medicaid residents, the solution to the monopolist problem is standard and may feature under- or oversupply of intensity relative to the competitive outcome, depending on the private demand elasticities with respect to intensity.

imply that higher number of residents coupled with the higher intensity raises the marginal cost of bed, $\mathcal{C}_N(n+m,Q)$, and reduces the profit margins on both types of beds. Holding the slope of the private demand, $\frac{\partial n}{\partial P}$, constant, lower profit margin on a private bed reduces the marginal cost of raising the price of bed (the left-hand side of (8)), while larger number of private payers increases return to raising the price (the right-hand side of (8)). However, whether the price increases depends on how the slopes of the demand responds to higher intensity, i.e., on the sign of $\frac{\partial^2 n}{\partial P \partial Q}$. Furthermore, increasing returns to scale in intensity reduce the marginal cost of an extra hour of care, further stimulating raising intensity of care. While it is unambiguous that both the number of Medicaid beds and intensity increase, the effects on the number and price of private beds are ambiguous. Both the nursing home and its Medicaid residents stand to benefit from the higher reimbursement rate while the private LTC recipient may be disadvantaged.

Medicaid generosity on demand side Now consider an increase in the consumption floor for the Medicaid nursing home residents, c^M. Property 2 in Proposition 3 states that a higher consumption floor stimulates demand for the nursing home care and increases the number of its residents, holding all else constant. The inflow of the Medicaid residents has a direct impact on the marginal costs of bed and care intensity, $\mathcal{C}_N$ and $\mathcal{C}_Q$, which reduce the profit margins on both types of beds and reduce incentives to provide higher intensity of care. At the same time, there are two channels that promote higher intensity: higher demand elasticities with respect to intensity and lower marginal cost of intensity. The former effect has been discussed in Proposition 3, property 3: A higher consumption floor amplifies the response of the Medicaid demand to a change in intensity provided the loss on the density margin is small or non-negative. The latter channel arises due to the assumption of increasing returns to scale in intensity. In the end, the effect on the intensity of care is ambiguous. Nevertheless, the price unambiguously increases and the number of private beds falls as the cost of raising the price on private beds declines. To sum up, a more generous policy on the demand side crowds out private beds with Medicaid beds and increases the price of bed, while its effect on the intensity of care and nursing home profits is ambiguous.

Thus, Medicaid generosity targeted at either the demand or supply side affects both sides of the nursing home market. Both policies increase the share of Medicaid beds and, hence, increase Medicaid outlays. A higher Medicaid reimbursement rate directly benefits nursing homes with some of the benefits being passed on to the existing and new residents in terms of a higher intensity. A higher consumption floor directly benefits existing Medicaid nursing home residents as well as those who switch from the out-of-pocket in-home care to the Medicaid nursing home in terms of consumption but has ambiguous effects on the intensity of care used.

4 Quantitative Model

Our quantitative model extends the stylized model in the following ways. On the household side, the optimization problem is dynamic. Retired households live for up to T years and face uncertainty about their health, which determines their LTC need, own and spouse survival, and, for those with children, child proximity. In addition to the LTC choice, they make saving decisions and value bequests. On the supply side, we explicitly model local competition among nursing homes.

4.1 Households

Households in our model are heterogeneous in their age, wealth, income, family structure, and health. We start by describing the household state, preferences, LTC options, government transfers, and the budget constraints faced by the household in each period given its state. The full dynamic problem of the household is presented at the end.

4.1.1 Household State

In each period, the following variables summarize the current state of a household:

1. Age (t): For simplicity, for couples, we assume that they have the same age.

2. Wealth (W_t): The total value of wealth owned by the household.[21]

3. Health ($\mathbf{h}_t = \{h_{m,t}, h_{f,t}\}$): This captures the health status of alive members of the household. Potential values it can take are *Good*, $Fair$, and *Bad*, where *Bad* means the individual needs help with ADLs. *Bad* is further divided into two states depending on how much help with ADLs needed: low need for help with the ADLs ($ADLL$), and high need for help with the ADLs ($ADLH$). Being *Good* and $Fair$ has no difference in terms of the current demand for long-term care (which is zero) but it affects the health transition probabilities.[22] It is a vector with two elements, capturing health of male ($h_{m,t}$) and female ($h_{f,t}$) separately.

[21] For tractability, we do not distinguish housing and financial wealth.

[22] In mapping these categories to the HRS, *Good* is defined as not needing help with ADLs and the self-reported health status being excellent, very good, or good; $Fair$ is defined as not needing help with ADLs and the self-reported health status being fair or poor.

4. Family status (F_t): This captures the following information: (i) whether the male and female spouses are alive or not; (ii) whether the household has a living child or not; (iii) if there is a living child, whether the household has a child within 10 miles or not.

5. Income ($\mathbf{Y}_t = \{Y_{m,t}, Y_{f,t}\}$): This captures the retirement income from Social Security and defined-benefit pensions for alive members of the household. It is a vector with two elements, capturing income of male ($Y_{m,t}$) and female ($Y_{f,t}$) separately.

6. Permanent income (PI): This captures the average earnings made while household members were working.

To simplify the notation, we omit the age subscripts in the household problems below. Next period variables are denoted with a prime ($'$).

The exogenous state variables evolve over time in the following way. Each member's health (h_m, h_f) evolves following a first-order Markov process, where it has the four states described above—*Good*, *Fair*, *ADLL*, and *ADLH*—as well as *Death* as the absorbing state. The health transition matrix is a function of age, gender, martial status (single versus coupled), and permanent income (PI) of households. Retirement income ($\{Y_m, Y_f\} = \mathbf{Y}$) does not change over time except when a member is widowed and starts receiving a survivor benefit. That is, this member is reassigned the larger value in the couple's income vector.[23] Lastly, the family situation (F) changes when one is widowed. Not only that household becomes single but also, for households with a child but not within the 10-mile radius, consistently with the HRS data, we allow for a 50% chance that a child moves within the 10-mile radius.

4.1.2 Preferences

Households face the following flow utility function:

$$U(\mathbf{c}, \mathbf{q}, \mathbf{k}; \mathbf{h}, F) \equiv \sum_{g=m,f} \mathbf{1}_g[\theta_g^h u(q_g^k; h_g) + \nu(c_g + \mathbf{I}^{k_g=\mathcal{N}}\Delta_{\mathcal{N}} + \mathbf{I}^{k_g=\mathcal{NM}}\Delta_{\mathcal{NM}})], \tag{10}$$

where $\mathbf{1_g}$ is the indicator function that takes the value of one if the member of the corresponding gender is alive, and zero otherwise. For couples, this is the sum of the utilities of two members. Each member's flow utility is composed of two terms: utility from LTC

[23]This is based on the following observations. For Social Security, the widowed can choose her/his own benefit or 100% of the deceased spouse's benefits. For defined-benefit pensions, Johnson et al. (2003) report that the vast majority (72%) of males, who are more likely to have higher retirement income, choose joint-and-survivor pensions while a small fraction (31%) of females do so.

consumption (the first term inside the square bracket) and that from non-care consumption (the second term).

The relative importance of care consumption is governed by the utility multiplier, θ_g^h. This parameter depends on the current health. In particular, it is zero when the health is *Good* or *Fair* (because we do not explicitly model health care other than long-term care), while it takes positive values when the health is *Bad*. u is an increasing and concave function of the hours of care received (q_g^k) and the superscript k refers to the type of care chosen (discussed below). Note that we allow the health state to affect not only θ_g^h but also u, to capture the possibility that the subsistence level of long-term care may be different between $ADLL$ and $ADLH$.

The non-care utility function, ν, is increasing and concave in the non-care consumption, which includes consumption of goods and services purchased, c_g, and the consumption value of a nursing home stay: $\Delta_{\mathcal{N}}$ for a private resident or $\Delta_{\mathcal{NM}}$ for a Medicaid resident (see below).

4.1.3 Long-term Care Options

When a member's health is *Bad*, households can choose to either enter a nursing home or use in-home care.[24] For each option, households can choose to pay out of pocket or to rely on Medicaid. Let $K \equiv \{\aleph, \aleph\mathcal{M}, \mathcal{H}, \mathcal{HM}\}$ denote the set of all the LTC options, where $\aleph \equiv \{1, ..., J\}$ denotes the set of nursing homes. Then for $j \in \aleph$, $k = j$ means entering nursing home j out of pocket and $k = j\mathcal{M}$ means entering it as a Medicaid resident. $k = \mathcal{H}$ means using in-home care paying out of pocket and $k = \mathcal{HM}$ means using it relying on Medicaid.

Nursing home j provides Q_j hours of care for both out-of-pocket ($k = j$) and Medicaid ($k = j\mathcal{M}$) residents. The differences between an out-of-pocket nursing home stay and a Medicaid nursing home stay are their costs and the consumption value of the stay. The out-of-pocket cost is P_j per year. Staying in a nursing home as a private patient also comes with consumption value, $\Delta_\aleph$ (assumed to be the same across nursing homes). Medicaid patients do not pay the cost of care out of pocket, but they can keep their wealth and income only up to certain limits (see the explanations on the transfers below in this subsection). The consumption value of Medicaid nursing home stay, $\Delta_{\aleph M}$, can be smaller than $\Delta_\aleph$. This is

[24] In the case when both members' health statuses are *Bad*, we do not allow them to choose different care options. Either both enter a nursing home or both use in-home care. This shouldn't have a noticeable impact on the results as it is very rare that both members need help with ADLs at the same time (happens to about 1% of households above age 70).

to capture the possibility of public care aversion (Ameriks et al., 2011) and nursing homes providing fewer amenities to public patients.

The main benefit of using in-home care out of pocket ($k = \mathcal{H}$) is the flexibility in choosing the care hours based on one's needs and preferences. The cost per hour of care is $\rho(F, \mathbf{h})$, so the total cost is $\rho(F, \mathbf{h})q_g$, where q_g is the hours of care demanded by the individual. Note that the unit price of care depends on the family structure and the health status. This is to allow for the possibility that the effective cost of using in-home care may be lower if they have a healthy spouse or a child living nearby. For single households, or for those with both spouses needing help with ADLs, they also need to pay for housekeeping services. We assume that those households need to pay additional fixed cost, Ξ, regardless of the number of care hours used.

For the Medicaid-funded in-home care ($k = \mathcal{HM}$), we assume that Medicaid pays up to some number of hours, $Q_{\mathcal{HM}}$. Because the out-of-pocket price is zero, individuals in the model always use the maximum allowed number of hours. Households using this option face the same regulation regarding income and wealth to be kept as in the Medicaid nursing home option.

4.1.4 Transfers

Transfers in our model ensure that non-care consumption does not fall below level Δ_W guaranteed by government programs. Moreover, households with long-term care needs are in addition subject to Medicaid regulations on the amount of income and wealth Medicaid enrollees can keep.[25] We assume that Medicaid pays care providers directly, so the LTC costs covered by Medicaid do not appear in the transfers to households. There are three potential cases.

- Households that do not receive care based on Medicaid receive a transfer when their own financial resources cannot cover the minimum non-care consumption Δ_W:

$$TR = max\{0, \sum_{g=m,f} \mathbf{1}_g \left[\Delta_W - Y_g\right] - W\}. \tag{11}$$

- Households with all members enrolled in Medicaid are not allowed to keep any income or wealth. In addition, each Medicaid enrollee using in-home care receives a

[25] This, in part, reflects the spend down of wealth before households become eligible for Medicaid, though we do not explicitly model intra-period switchings in LTC choices.

consumption transfer which guarantees the minimum non-care consumption:

$$TR = \sum_{g=m,f} \mathbf{1}_g \left[\Delta_W \mathbf{I}^{k_g=\mathcal{HM}} - Y_g\right] - W. \tag{12}$$

- Coupled households such that one member ($g = i$) is a Medicaid LTSS enrollee and the other member ($g = j$) does not require long-term care can keep a part of their income and wealth according to the following rules. For income, the healthy spouse can keep the larger value between her/his income and a certain lower bound that is set to prevent impoverishment of the healthy spouse ($\underline{Y}$). For wealth, the household can keep the full amount of its assets up to the threshold $\underline{W}$, and 50% of wealth above $\underline{W}$. The amount of wealth it can keep cannot be larger than $\underline{W} + \bar{W}$, where $\bar{W}$ is the parameter that puts the upper bound on the wealth kept in conjunction with $\underline{W}$. Hence, the transfer is determined as:

$$\begin{aligned} TR = {} & \Delta_W \mathbf{I}_i^{k_i=\mathcal{HM}} - W - \sum_{g=m,f} \mathbf{1}_g Y_g + \max\{Y_j, \underline{Y}\} \\ & + \min\{W, \underline{W}\} + \max\left\{0, \min\left[0.5\,(W - \underline{W}), \bar{W}\right]\right\}. \end{aligned} \tag{13}$$

For the parameters used to specify the exact Medicaid eligibility criteria (and hence the transfers according to the above equations), there are variations across states. We set these parameters based on the rule from Pennsylvania (see Section 5).

4.1.5 Budget Constraint

The budget constraint defines the evolution of the household beginning-of-period wealth W:

$$W' = (1+r)\left(W + \sum_{g=m,f} \mathbf{1}_g \left[Y_g - c_g - LTC_g^k(q_g, \mathbf{h}, F)\right] + TR\right). \tag{14}$$

Wealth is accumulated with the retirement income net of expenditures and government transfers (TR) associated with Medicaid LTSS programs. Expenditures include consumption of non-care goods and services and out-of-pocket costs of care services. The latter depends on the health as well as type and quantity of care received:

$$LTC_g^k(q_g, \mathbf{h}, F) = \begin{cases} P_j & \text{if } k = j \ \ \forall j \in \aleph \\ \rho(\mathbf{h}, F) q_g + \Xi(\mathbf{h}, F) & \text{if } k = \mathcal{H} \\ 0 & \text{if } k \in \{j\mathcal{M}\}_{j \in \aleph};\ k = \mathcal{HM};\ \text{or } h_g \in \{G, F\}. \end{cases}$$

The last case indicates that the LTC expenditure is zero for Medicaid enrollees and for those in *Good* or *Fair* health.

4.1.6 Full Dynamic Problem

Let $\mathbf{X} \equiv \{t, W, \mathbf{h}, F, \mathbf{Y}; PI\}$ be the set of household-specific states and $\mathbf{P}$ and $\mathbf{Q}$ be the vectors of prices and care intensity set by the nursing homes. The value of care option $\mathbf{k} \in \{0, K\}$, where $k = 0$ applies to households without LTC needs is determined by solving

$$V^k(\mathbf{X}; \mathbf{P}, \mathbf{Q}) = \max_{\mathbf{c}, \mathbf{q}, W'} \{U(\mathbf{c}, \mathbf{q}, \mathbf{k}; \mathbf{h}, F) + \beta \mathbf{E}\left[\eta(t, \mathbf{h}, F; PI) V(\mathbf{X}'; \mathbf{P}, \mathbf{Q}) + (1 - \eta(t, \mathbf{h}, F; PI)) b(W')\right]\} \quad (15)$$

where $\mathbf{X}' = \{t + 1, W', \mathbf{h}', F', \mathbf{Y}'; PI\}$, and subject to the budget constraint (equation 14), the transfer rules (equations 11–13), the stochastic transitions of health and associated transitions of retirement income and family status explained in Section 4.1.1. β is a time discount factor, η is the probability of survival, and b is the bequest utility function. $V(.)$, the continuation value of the household, is determined by the choice of care type k as follows:

$$V(\mathbf{X}; \mathbf{P}, \mathbf{Q}) = \begin{cases} V^k(\mathbf{X}; \mathbf{P}, \mathbf{Q}) & \text{if } k = 0, \\ \mathbf{E}_\xi \left[\max_{\mathbf{k}} \{V^k(\mathbf{X}; \mathbf{P}, \mathbf{Q}) + \theta_g^h \xi_g^k \sigma_\xi\}\right] & \text{if } k \in K. \end{cases}$$

where ξ_g^k is a preference shock drawn for each care option available, *iid* across nursing homes, time, and households, and scaled by $\theta_g^h \sigma_\xi$. The preference shock effectively introduces heterogeneity in the goods produced by nursing homes, which is necessary for modelling the competition of nursing homes on price consistently with the long-term care market evidence. In our model, the preference shocks account for other factors relevant for the choice but not explicitly modeled, such as distance from family and specific nursing home amenities. σ_ξ governs the relative importance of the preference shocks.[26] Assuming the shocks are drawn from a standard extreme value type I distribution, the probability of choosing care option

[26] Scaling the preference shocks by θ_g^h ensures that the relative importance of the preference shocks are similar across states with different needs for care.

$k \in K$ by the household member g is given by:

$$\pi_g^k(\mathbf{X};\mathbf{P},\mathbf{Q}) = \frac{\exp\left(V^k(\mathbf{X};\mathbf{P},\mathbf{Q})/(\theta_g^h\sigma_\xi)\right)}{\sum_{\tilde{k}\in K}\exp\left(V^{\tilde{k}}(\mathbf{X};\mathbf{P},\mathbf{Q})/(\theta_g^h\sigma_\xi)\right)}. \tag{16}$$

4.1.7 Demand for Nursing Home Care

The solution to the optimization problem (15) produces individual probabilities of selecting each care option. Let $\Psi(\mathbf{P},\mathbf{Q})$ denote the distribution of households over the state space $\mathcal{X} \equiv \{\{1,\ldots,T\}\times R_+\times\{Death, Good, Fair, ADLL, ADLH\}\times\{Death, Good, Fair, ADLL, ADLH\}\times\{No\ Child, Child\ nearby, Child\ not\ nearby\}\times R_+^2\times R_+^2\}$. Aggregated across individuals, the probabilities give rise to the private and Medicaid demand schedules for nursing home j:

$$n_j(\mathbf{P},\mathbf{Q}) = \int_{\mathbf{X}\in\mathcal{X}}\sum_{g=m,f}\mathbf{1}_g\pi_g^j(\mathbf{X};\mathbf{P},\mathbf{Q})d\Psi(\mathbf{P},\mathbf{Q}), \tag{17}$$

$$m_j(\mathbf{Q}) = \int_{\mathbf{X}\in\mathcal{X}}\sum_{g=m,f}\mathbf{1}_g\pi_g^{j\mathcal{M}}(\mathbf{X};\mathbf{P},\mathbf{Q})d\Psi(\mathbf{P},\mathbf{Q}), \tag{18}$$

where $n_j(.)$ and $m_j(.)$ are residual demands for nursing home j from private payers and Medicaid enrollees, respectively. As in Section 3, given the Medicaid rules, demand from the Medicaid enrollees (18) depends only on the care intensities, $\mathbf{Q}$, and not the prices, $\mathbf{P}$. The private demand depends on both prices and intensities of care. Moreover, the *iid* preference shocks ensure that the demand schedules are symmetric across the nursing homes.

4.2 Nursing Homes

On the supply side, there are J nursing homes that face identical cost structure. They observe the demand for nursing home care and compete in a local market by simultaneously choosing price and intensity of care.

Nursing home j takes as given prices and care intensity of the other nursing homes ($\mathbf{P}_{-j}$ and $\mathbf{Q}_{-j}$) on the market and maximizes profits by choosing its price and intensity:

$$\max_{P_j,Q_j} n_j(P_j,Q_j|\mathbf{P}_{-j},\mathbf{Q}_{-j})P_j + m_j(Q_j|\mathbf{Q}_{-j})M - \mathcal{C}(N_j,Q_j) - \chi, \tag{19}$$

$$\text{where } N_j = n_j(P_j,Q_j|\mathbf{P}_{-j},\mathbf{Q}_{-j}) + m_j(Q_j|\mathbf{Q}_{-j}) \tag{20}$$

where χ is the per-period fixed cost of operation and M is the Medicaid reimbursement rate.

N_j is the total number of patients.[27] The variable cost function $\mathcal{C}(.)$ is an increasing function of both the number of patients and the intensity of care.

Since nursing homes in our model face the same cost structure, the solution to the problem is identical for all J nursing homes given the demand schedules. The associated first order conditions are similar to the ones derived in Section 3:

$$-(P_j - \mathcal{C}_N(N_j, Q_j))\frac{\partial n_j}{\partial P_j} = n_j(N_j, Q_j|\mathbf{P}_{-j}, \mathbf{Q}_{-j}), \tag{21}$$

$$(M - \mathcal{C}_N(N_j, Q_j))\frac{\partial m_j}{\partial Q_j} + (P_j - \mathcal{C}_N(N_j, Q_j))\frac{\partial n_j}{\partial Q_j} = \mathcal{C}_Q(N_j, Q_j). \tag{22}$$

As in the simple model in Section 3.2., decreasing returns to scale in the number of beds create a trade-off between the number of Medicaid and out-of-pocket residents. The nursing home uses intensity of care to control the total number of residents and the out-of-pocket price to control the composition of residents. The relative demand elasticities play a key role in the trade-off.

4.2.1 Nursing Home Market Equilibrium

Symmetric solutions to the nursing home problems given the demand schedules and symmetric demand schedules faced by the nursing homes imply that we can focus on a symmetric Nash equilibrium:

Definition *Given the Medicaid LTSS policy—reimbursement rate (M) and the transfer rules (TR) for the households, where the latter determines the residual demands (17) and (18) faced by each nursing home $j \in \{1, ..., J\}$, a nursing home market equilibrium is a pair of symmetric price and quality vectors—$\mathbf{P}^\star$ and $\mathbf{Q}^\star$, where $P_j = P^\star$ and $Q_j = Q^\star$ for all $j \in \{1, \cdots, J\}$—such that for each nursing home j, $P_j = P^\star$ and $Q_j = Q^\star$ maximize its profit (19) given $\mathbf{P}^\star_{-j}$ and $\mathbf{Q}^\star_{-j}$.*

The resulting equilibrium allocation of beds is symmetric across nursing homes: $n^\star = n_j(P^\star, Q^\star)$ and $m^\star = m_j(Q^\star)$, $j \in \{1, \cdots, J\}$. Although we do not model the market-entry stage of the game, we check that the profit (19) obtained under $\mathbf{P}^\star$ and $\mathbf{Q}^\star$ is positive but not large enough to induce a new nursing home to enter given entry cost $\mathcal{E}$, such that J is the equilibrium number of nursing homes.

[27] We do not model the capacity constraint from the Certificate-of-Needs law as it does not apply to the Pennsylvania nursing home market.

5 Parameterization

We parametrize the model in three steps. First, we set the values of parameters which can be directly inferred from the macro data, the Medicaid rules, or existing literature. Second, we estimate the health transition processes and the number of nursing homes in the local market using micro data. Third, for the parameters with no direct macro or micro evidence, we use an indirect inference methodology which solves for the model parameters by targeting a set of relevant empirical moments with the equilibrium model moments. Table 3 lists the parameters in the model and the assigned values. In the rest of this subsection, we explain the parameterization in more detail.

5.1 Preferences

We use a standard CRRA utility function for non-care consumption:

$$\nu(c) = \frac{c^{1-\gamma_1}}{1-\gamma_1}. \tag{23}$$

We set $\gamma_1 = 3$, which is a standard value in the literature.

For care consumption, we use a CRRA utility function with a subsistence level of care consumption ($\kappa_h > 0$):

$$u(q;h) = \frac{(q-\kappa_h)^{1-\gamma_2}}{1-\gamma_2}. \tag{24}$$

The subsistence level of care consumption governs the left tail of the distribution of care hours used (q). We set it to be 300 hours per year for $h = ADLH$ and 50 hours per year for $h = ADLL$ to match the 25-th percentiles of the distribution of q from the model to their empirical counterparts, conditional on h. Note that with the utility multiplier, θ_h, in the overall flow utility function (equation 10), our utility function essentially has the same functional form as in Ameriks et al. (forthcoming). The utility multiplier affects the overall level of care consumption. We set it to match the average care hours used, conditional on being ADLL and ADLH, separately. We allow preferences over care and non-care consumption to differ in the risk aversion. In fact, to reproduce the long right tail of care hours in the data, the model requires that the marginal utility of care consumption diminishes more slowly than that of the non-care consumption utility function, achieved with $\gamma_2 < \gamma_1$. More specifically, we target the mean/median ratio of care hours under $ADLH$, and set $\gamma_2 = 1.2$.

Table 3: List of the parameters and their values

Parameter	Value	Description	Source/Target
A. Taken from the literature or the Medicaid rules			
γ_1	3	Risk aversion over non-care consumption	Standard value
β	0.97	Time discount factor	Standard value
r	0.03	Real interest rate	
θ_b, κ_b	1, -$8K	Bequest utility function parameters	Ameriks et al. (forthcoming)
$\Delta_{\mathcal{N}}$	$20K	Consumption value of OOP stay at a NH	Hackmann (2019)
ρ w/o family	$35	In-home care per hour cost w/o family support	Mommaerts (2016)
Ξ	$20K	Fixed cost of using in-home care w/o family support	Achou (2016)
M	$76.5K	Medicaid reimbursement rate for NHs	Hackmann (2019)
Δ_W	$10K	Consumption under welfare	Supplemental Security Insurance
χ	$1.3M	NH fixed cost of operation	Hackmann (2019)
$\underline{Y}, \underline{W}, \bar{W}$	$25K, $60K, $120K	Medicaid eligibility parameters	PA Medicaid rules
B. Estimated from the data			
Π_H	See Appendix A	Health transition matrices	HRS data
J	11	Number of nursing homes	PA Department of Health data

Note: Dollar values are in 2017 dollars. Flow variables are reported in terms of per-year values.

Table 3: List of the parameters and their values (continued)

Parameter	Value	Description	Source/Target
C. Determined using indirect inference			
γ_2	1.2	Risk aversion over care consumption	Mean/median ratio in q under ADLH
θ_h, κ_h	0.0009, 300 for $h = ADLH$ 0.00021, 50 for $h = ADLL$	Care utility function parameters	Mean and 25-pctl of q
σ_ξ	0.1	S.d. of preference shocks	Share of care type choice explained by observables
$\Delta_{\mathcal{NM}}$	\$10.1K	Consumption value of Medicaid stay at a NH	Share of NH among Medicaid patients
ρ w/ family	\$17.5	In-home care per hour cost w/ family resources	Difference in the in-home care share between w/ and w/o family
$\bar{c}$	0.177	Level of NH cost function	Profit after the fixed cost
α, β	1.277, 0.665	Returns to scale in NH cost function	Satisfying 21 and 22 at $P_j = \$85K$ and $Q_j = 2,000$

Note: Dollar values are in 2017 dollars. Flow variables are reported in terms of per-year values.

However, in the data, the selection into in-home care and nursing-home care is only partially explained by the observable characteristics. As documented in Table 2, conditional on the household resources, a less favored option is still chosen with a significant probability. Preference shocks ξ^k, drawn from the extreme value type I distribution, capture other factors not explicitly modeled here. The scale of the preference shock, σ_ξ, governs the probability of the less preferred option to be chosen conditional on observables. We set the value of this parameter such that the overall probabilities assigned to the less preferred options, conditional on observables, are close to the numbers reported in Table 2 (see Section 5.6).[28]

We set the risk-free interest rate (r) to be 3 percent per year and the time discount factor (β) such that $\beta = \frac{1}{1+r}$. Following Ameriks et al. (forthcoming), we use the following functional form for the bequest utility function:

$$b(W) = \theta_b \frac{(W - \kappa_b)^{1-\gamma}}{1-\gamma}, \tag{25}$$

where θ_b determines the overall strength of the bequest motive while $\kappa_b < 0$ makes the bequest a luxury good compared to non-care consumption. Based on the estimates from Ameriks et al. (forthcoming), we set $\theta_b = 1$ and $\kappa_b = -\$8K$.

5.2 Initial Joint Distribution and Health Transitions

The model starts from age 70 and individuals can live up to age 110 ($T = 110$). To obtain the initial joint distribution of the state variables at the youngest age (70), we use the cross-section of the following households from a single wave (HRS 2014): (i) single households between ages 68 and 72; (ii) coupled households with an average age between 68 and 72 and where the age difference between the spouses is less than 10 years. There are 1,247 such households.

Starting from this initial joint distribution, we generate a representative population of Americans older than 70 from the model by simulating their health transitions using the transition matrices estimated from the HRS data.[29] Note that we do not allow for aging of the population as we focus on the stationary distribution in a nursing home market.

[28]To make sure that options which are equally valued net of the preference shock—in-home care versus nursing home—are chosen with equal probabilities regardless of the value of ξ^k, we allow the households to draw J preference shocks for the out-of-pocket in-home option and J shocks for the Medicaid in-home care—symmetrically to the nursing home options. This can be viewed as a choice over multiple in-home care agencies which we do not model explicitly.

[29]To reduce the sampling error in the simulation, we create 100 clones of each household from the initial joint distribution. We apply the sampling weights from the HRS, which are rescaled to have the total elderly population in the model as the same as that in an average nursing home market according to the Pennsylvania Department Health data and the census (24,000), in all the analyses in this paper.

The transition matrices over the five health states ($Good, Fair, ADLL, ADLH$, and death) are functions of the age and gender of each member, whether single or coupled, as well as the permanent income (PI) of the household, as in Jones et al. (2018). We measure the permanent income as the sum of Social Security and defined-benefit pension incomes because that can be considered as a proxy for the lifetime earning of households. See Appendix A for more details on the transition matrix estimation and the stationary distribution of population in terms of age, health, and family structure.

5.3 Long-term Care Costs

The out-of-pocket cost and care intensity of a nursing home stay are determined in the equilibrium, as an outcome of local competition among nursing homes. As explained below, we set the parameters in the nursing home cost function such that the equilibrium price (P_j) and the intensity (Q_j)—which are common across nursing homes in the symmetric equilibrium—are \$85K per year and 2,000 hours per year, respectively, based on the Nursing Home Reports data for the former and the standard value used in the literature for the latter (e.g., Mommaerts, 2016). Regarding the consumption value of an out-of-pocket nursing home stay ($\Delta_{\mathcal{N}}$), Hackmann (2019) reports that the non-health-related resident cost for a nursing home is about one-third of the health-related cost. Based on this, we assume that $\Delta_{\mathcal{N}} = \$20K$, approximately a quarter of the out-of-pocket expense. We set $\Delta_{\mathcal{NM}}$ to be \$10.1K, about half of $\Delta_{\mathcal{N}}$, to match the share of Medicaid patients that enter a nursing home, which is an increasing function of this parameter.

The in-home care expenses are composed of two parts for those without family support: The per-unit price (ρ_S, where NF stands for no family support) and the fixed cost of using in-home care (Ξ). Genworth (2019) reports that, in 2019, in-home care costs between \$20 and \$50 per hour depending on the qualification of care provider and types of care needed. We set ρ_S to be \$35 per hour (in 2017 dollars), which is close to the upper bound of this range. We make this choice because the unit of care hour used for this option should be comparable to that in nursing home care where care is typically provided by skilled nurses. This value is also consistent with the formal heavy-care cost used in Mommaerts (2016). Ξ captures the fact that to receive care at home while not having any family to rely on, the patient also has to purchase services that replace basic home production. Achou (2016) reports that the average home production among older couples is between 1,000 to 1,500 hours per year. We set Ξ to be \$20K per year based on this information. We assume that individuals with family support do not face a fixed cost of using in-home care. In addition, we allow the unit cost of in-home care be lower for those with family to reflect the lower opportunity costs (foregone wages and/or leisure) of care providers.[30] We set ρ_F to be half of ρ_S, to match the difference in the share of in-home care between those who do and do not have family support.

Note that, for private patients whose demand for care is close to 2,000 hours per year and without family support, entering a nursing home is a more cost-effective option than using in-home care. Given that a nursing home stay comes with \$20K of consumption value, the effective cost of 2,000 hours of care is \$65K. For in-home care, individuals without family support need to spend \$70K to receive 2,000 hours of care (\$35 $\times$ 2000), so even without taking into account the fixed cost of using in-home care (Ξ), in-home care is a more expensive option. This reflects the increasing returns to scale over the intensity of care feasible under the institutional setup (see below). Of course, for those whose demand for care is not close to 2,000 hours per year, or for those with family support, in-home care will be a more economical option.

5.4 Medicaid Rules and SSI Transfer

There are variations across states in how much income and wealth households with a Medicaid patient and a healthy spouse can keep. We set the values of the parameters in this rule based on Pennsylvania.[31] The minimum amount of income to be kept ($\underline{Y}$) is set to be \$25K, which is the average between the minimum (\$20K) and the maximum (\$30K) values of the Minimum Monthly Maintenance Needs Allowance set by the federal government. The threshold up to which households can keep the full value of its wealth ($\underline{\mathrm{W}}$) is set to be \$60K, based on the fact that the spouse in the community can keep the house and the median value of home equity among couples that are under Medicaid in the HRS is \$60K. The maximum amount of wealth those households can keep in addition to the home equity ($\bar{W}$) is \$120K in Pennsylvania.

The Medicaid reimbursement rate (M), the amount that Medicaid pays to nursing homes per Medicaid patient, is set to be \$76.5K based on Hackmann (2019), which is 10% lower than the out-of-pocket price.

We also allow for the non-care consumption floor (Δ_W) for the households who do not have resources to maintain this level of consumption. We set Δ_W to be \$10K per year based on the Supplemental Security Income.

[30] If the informal care is provided by an already retired, healthy spouse, the opportunity cost is composed only of foregone leisure. Even for the other cases, the effect of informal caregiving on labor supply is significant only for highly-intensive caregiving (Butrica and Karamcheva, 2014).

[31] https://www.medicaidplanningassistance.org/medicaid-eligibility-pennsylvania

5.5 Nursing Home Costs

In the baseline model, there are 11 nursing homes competing in one local nursing home market, which is 700 square miles in area and has 24,000 people, aged 70 years or older (see Section 2.2). Nursing homes incur a fixed cost of operation (χ), which is set to be \$1.3M per year based on Hackmann (2019). We use the following functional form for the variable cost function:

$$\mathcal{C}(N_j, Q_j) = \bar{c} N_j^{\alpha} Q_j^{\beta}. \tag{26}$$

It is governed by three parameters: the scale parameter $\bar{c}$ and the curvature parameters α and β that determine the returns to scale over the number of patients and the intensity of care, respectively. We set $\bar{c}$ such that, at the equilibrium price ($P_j =$\$85K) and intensity ($Q_j = 2,000$ hours) in the baseline, each nursing home has the level of profit that is positive net of the fixed cost of operation (χ) but not too large, so that the current number of nursing homes ($J = 11$) can be supported as an equilibrium. Setting $\bar{c} = 0.177$ generates such a level of profit (see Section 5.6 for more details). The values of α and β target the clearance of the FOCs (equations 21 and 22) from the nursing home's maximization problem at the equilibrium price and intensity in the baseline. The cost function with the inferred parameter values suggests that the nursing homes have decreasing returns to scale over the number of residents ($\alpha = 1.277 > 1$) and increasing returns to scale over intensity ($\beta = 0.665 < 1$). The former reflects the physical capacity constraint on the number of beds, and keeps the size of nursing homes consistent with that observed in the data (on average about 140 patients per nursing home). The latter may reflect that additional measures they take to increase the intensity of care (e.g., hiring skilled nursing staff and specialists, purchasing medical equipment or providing better amenities) can be efficiently shared by residents in the institutional set up while it is not possible for in-home care.

5.6 Model Performance

In this subsection, we show that our quantitative model matches the targeted moments well, on the intensive margin (the number of care hours used) as well as the extensive margin (the type of care used). We also test the model performance on some non-targeted moments.

Table 4 presents the targeted moments. Empirical and model-generated moments line up very closely. Panel A shows that the model does a good job in matching the intensive margin of the distribution conditional on health status, in terms of the average (the target for θ_h), the 25th percentiles (the target for κ_h), and the mean-to-median ratio (the target for γ_2).

On the extensive margin, conditional on being $ADLH$, those who have family support—i.e., those with either a healthy spouse or a child within 10 miles—are 24 percentage points more likely to use in-home care. This is generated from the model by having the effective cost of in-home care to be much lower for those with family support (ρ_F) than for those without family support (ρ_S). For those on Medicaid, entering a nursing home and using in-home care are almost equally likely, which is generated by having the consumption value of being in a nursing home as a Medicaid patient ($\Delta_{\mathcal{NM}}$) to be about the same as the consumption floor guaranteed for a Medicaid patient using in-home care (Δ_W).[32]

Table 4: Model fit for the targeted moments

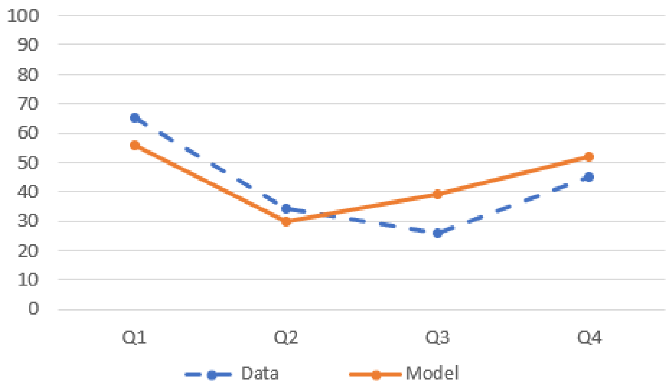
A. Care hours distribution					
Health status	25p	50p	Mean	Mean/Median	N (Data)
Data					
ADLH	1,188	2,000	2,574	1.28	1,723
ADLL	288	744	1,355	1.82	1,205
Model					
ADLH	1,238	2,000	2,493	1.25	
ADLL	248	840	1,320	1.57	
B. Share of in-home care (under ADLH)					
Conditions			**Data**	**Model**	N (Data)
Have family help			73	75	1,408
Do not have family help			49	51	315
On Medicaid			49	47	486

Note: Tabulation uses the sample in their 80s. For the care hour distribution, a nursing home stay is coded as 2,000 hours per year.

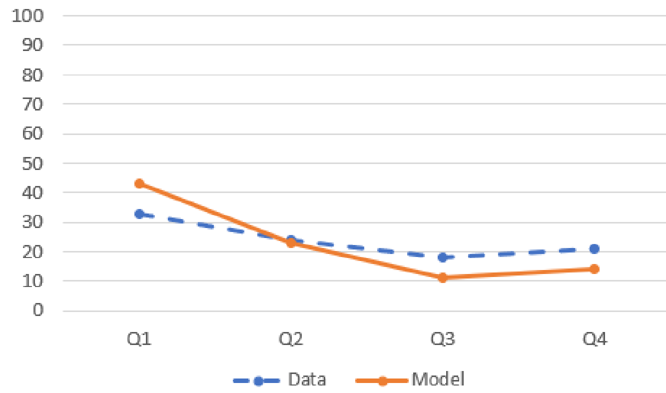
The main focus of our quantitative model is to reproduce the LTC demand patterns across health, family status, and financial resources. The targeted moments mostly span the first two dimensions. In Figure 3, we examine the model's ability to reproduce patterns of LTC utilization across wealth and income quartiles. The empirical moments in Figure 3 (dashed lines), which is a reproduction of Panel A of Table 2, show that the choices are far from being deterministic even after conditioning on health, wealth/income, and family status—the less preferred option is still chosen with a significant probability in every case. Among the 16 cases considered in Figure 3, the average probability that the less preferred option to be chosen is 33.4%. This was the target for σ_ξ, and the model closely matches that moment (34.1%). Furthermore, Figure 3 shows that the share of nursing-home care has a U-shape over financial resources, in particular over wealth. At first, it decreases with financial

[32]Recall that we assume a Medicaid nursing home stay and using in-home care as a Medicaid patient are equal in terms of the intensity of care, i.e., $q = 2,000$.

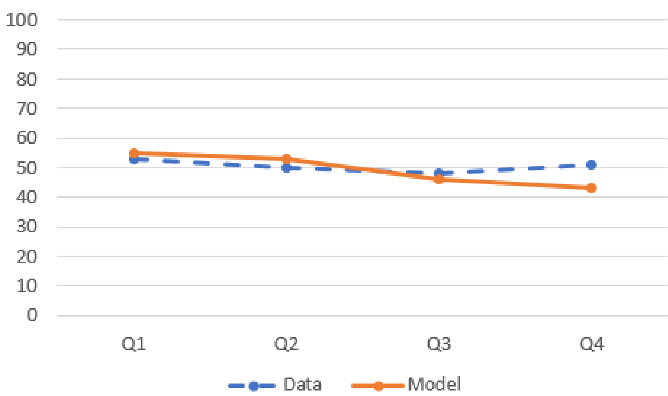
Figure 3: Share of nursing-home care (%) conditional on family and financial resources



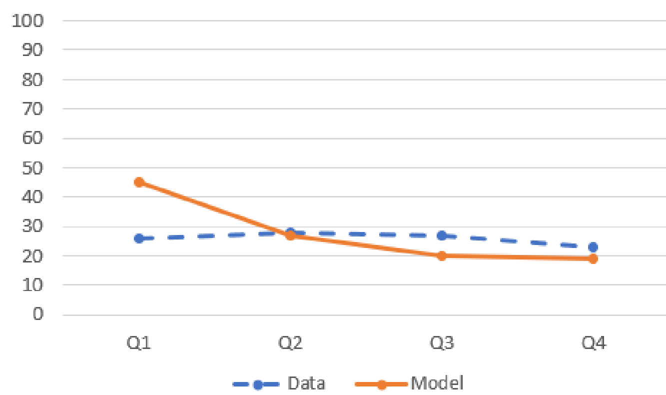
(a) No family, by wealth quartiles



(b) Family, by wealth quartiles



(c) No family, by income quartiles



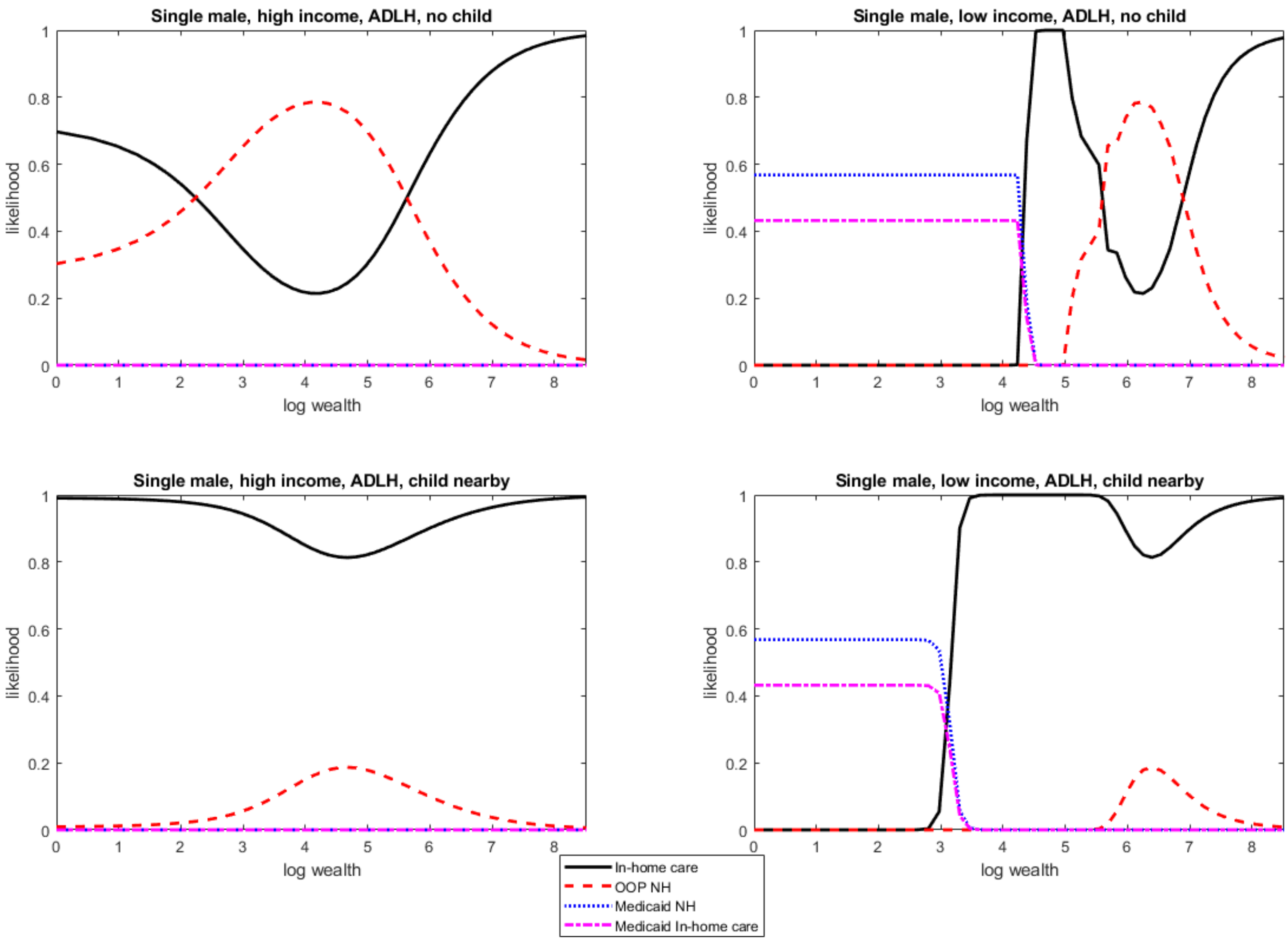
(d) Family, by income quartiles

Note: Figure uses the sample in their 80s and under ADLH.

resources and then increases. Similar patterns are generated from the model (solid lines), though the variation in these moments over wealth and income quartiles are not targeted. The size of the slopes is also similar between the data and the model. The only dimension with a gap is over income quartiles for those with family: The empirical moments are mostly flat while the model moments decrease with income.

The model also does a good job in matching how often the Medicaid option is used even though this is not targeted. After adjusting the under-reporting of Medicaid participation, 39.2% of households in age 80s with an individual under ADLH are Medicaid enrollees in the HRS data (Section 2.1). In the model simulation, the corresponding number is 41.6%. So overall, our model is successful in accounting for how health, family, and financial resources affect the key long-term care choices.

Figure 4: Likelihood of choosing care options (ADLH, 80 years old)



Note: The unit of the horizontal axis is log of wealth, where wealth is measured in multiples of \$1,000. For example, log wealth of 4 corresponds to the wealth level $\exp(4) \times \$1,000 = \$55,000$.

To see what forces in the model generate the observed moments, Figure 4 shows how the likelihood of choosing each care option varies as a function of family support and financial resources for an 80-year-old single male under $ADLH$. The patterns are essentially the same as what the stylized model (Section 3) predicts, except that the quantitative model now also allows for roles of unobserved factors in the form of preference shocks (hence, the choices are not deterministic). To see the impact of income, we compare the figures in the left (with a very high level of income, \$1M per year) and those on the right (with a very low level of income, \$10K per year). For those with a high level of income, Medicaid is never a relevant option. When they have almost no wealth other than income, they would prefer using in-home care over entering a nursing home, as the intensity of care they want to use is below 2,000 hours per year. As the wealth level goes up, the optimal intensity of care approaches 2,000 hours per year, which means that entering a nursing home becomes more attractive. Indeed, for those who do not have family support (the top-left figure), entering a nursing home becomes more likely to be chosen for wealth levels between \$12K and \$250K (log of wealth between 2.5 and 5.5). For those with families (the bottom-left figure), in-home care stays as a dominant option at any wealth level. For those with a low level of income, if they haven't accumulated enough wealth, they will be a Medicaid patient. For them, entering a nursing home and using in-home care is almost equally likely. As we increase the wealth level, we see that at some point, using in-home care out of pocket becomes a dominant option. They have too much financial resources to be a Medicaid patient but too little to enter a nursing home out of pocket. The wealth level where the out-of-pocket in-home care becomes a dominant option is lower for those with family resources (the bottom-right figure) than for those without family resources (the top-right figure). Again, entering a nursing home becomes more attractive as the wealth level further increases, resulting in the U-shape of the nursing-home care share over financial resources.

At the equilibrium price (P_j =\$85K) and intensity ($Q_j = 2,000$), each nursing home has about 140 patients, where three-quarters of those are Medicaid patients. The revenue for each nursing home is about \$10.7M, while the variable cost is \$7.5M, making the annual profit before the fixed cost to be around \$3.2M. This is larger than the fixed cost of operation (\$1.3M). Though we do not have a direct measure of the entry cost ($\mathcal{E}$), the present value of the profits net of fixed cost of operation is arguably not large enough to make an entry of a new nursing home market profitable. Hence, the number of nursing homes in the baseline model ($J = 11$) is supported as an equilibrium in the market.

6 Policy Experiments

In this section, we use our quantitative model to investigate the effects of LTSS policy experiments on households, nursing homes, and Medicaid expenditures. We first examine two policy experiments that target the supply-side of the market and then study two policy experiments that target the demand-side of the market. For each policy considered, we examine how equilibrium price and intensity of nursing home care, as well as demand for it, change compared to the baseline model.[33] We also show changes in the consumer surplus (and

[33]Since the policy impacts on nursing home profits are not large enough to induce an entry or an exit, we abstract from considering changes in the number of nursing homes on the local market, except for the subsidized entry case.

its distribution over heterogeneous households), producer surplus, and Medicaid expenditures to examine the efficiency as well as the distributional impacts of the considered policy.[34] For all the experiments, we highlight the importance of fully capturing the feedback between the changed household demand and the pricing and intensity decisions of nursing homes in correctly assessing the policy outcomes.

6.1 Supply-Side Targeted Policy Experiments

In this section we examine two public policies targeting the supply side of the nursing home market: *(i)* an increase in the Medicaid reimbursement rate for nursing homes, and *(ii)* a nursing home entry subsidized by the government. There is large literature assessing the effects of the Medicaid reimbursement rate on nursing home care intensity. While theory predicts positive effects (Gertler, 1989, and Nyman, 1985), non-structural estimation produced various results (see Grabowski, 2001 for a review). More recently, Hackmann (2019) used a structural approach to estimate effects of Medicaid reimbursement policy, as well as subsidized entry of a nursing home. Our quantitative analysis complements the work of Hackmann (2019) in that we incorporate a micro-founded demand side into our analysis.

6.1.1 Increasing Medicaid Reimbursement for Nursing Homes

The Medicaid reimbursement rate is set based on the average variable costs faced by nursing homes in a given market. In the baseline model, based on the observations from Pennsylvania, it is set 10% below the out-of-pocket price. We now examine the effects of increasing the Medicaid reimbursement rate by 10% ($7,650). The results of the experiment are reported in Tables 5 (the second and third columns), 6 and 7 (the first two columns).

As discussed in Section 3.2, higher return on Medicaid beds induces nursing homes to increase care intensity in order to attract more Medicaid residents but the effect on price and number of private beds is theoretically ambiguous. Table 5 reports that intensity increases by 68 hours per year (3.2%), attracting about 4 additional Medicaid residents per nursing home. Higher care intensity and additional Medicaid residents increase the marginal cost of bed by $1,900 per year (2.8%) which nursing homes pass entirely to the private residents by increasing the price by the same amount (2.2%). As a result, each nursing home loses

[34] The consumer surplus is calculated as one-time wealth transfers that need to be made to the youngest households (age 70) in the baseline model to give them the same utility as with the policy experiment. The policies will affect the welfare and behavior of even those households that do not currently need LTC as forward-looking households take into account the changes in LTC options and better or worse insurance provided by Medicaid under the considered policy. Also, we do not model how additional funds needed to implement the policies are financed. Therefore, we do not take into account the distortionary effects of taxes used to finance the policy change.

0.6 of the private bed, with a null change for private revenue due to the higher price. As each nursing home collects \$1.13M (13.9%) more in Medicaid reimbursements, the profits increase by \$0.76M or 37.4%.

Table 5: Supply-side targeted policy experiments: effects on a nursing home

	Baseline	Increased Medicaid reimbursement rate		Subsidized entry of a NH	
		Δ	$\Delta\%$	Δ	$\Delta\%$
NH care intensity (Q_j, hours per year)	2,000	+64	+3.2	−155	−7.3
NH price (P_j, \$K)	85.0	+1.9	+2.2	−4.1	−10.7
Marginal cost (\$K)	69.2	+1.9	+2.8	−6.3	−8.2
Private residents	31.2	−0.6	−1.9	+4.3	+13.8
Medicaid residents	106.2	+3.8	+3.6	−19.5	−18.4
NH private revenue (\$M)	2.65	+0.01	0.0	+0.05	+1.9
NH Medicaid revenue (\$M)	8.13	+1.13	+13.9	−0.50	−18.4
NH profits (\$M)	2.03	+0.76	+37.4	−0.08	−3.9
NH residents on Medicaid, %	77	+1.0	+1.3	−8.0	−7.8

The increase in the care intensity we find is consistent with the estimates in Grabowski (2001) and Hackmann (2019). However, Hackmann (2019) finds a larger, 8.7%, increase in intensity measured in care hours and the opposite effect on the out-of-pocket price, which declines by 4.5%. Hackmann (2019)'s assumption of constant return to scale in the size of nursing home ($\alpha = 1$) removes one of the key channels through which the equilibrium price goes up—the increased marginal cost due to a larger number of patients. On the other hand, Hackmann (2019) models non-profit nursing homes which place a non-monetary value on the number of residents they admit, while our quantitative analysis abstracts from the differences in objective functions among nursing homes for tractability.

The response of the demand side to higher price and intensity of nursing home care appears to be limited on aggregate. However, there are important distributional effects which we present in Figure 5a and report with more detail in Table 6. Figure 5a maps net flows among the four pools of long-term care consumers: private and Medicaid nursing home residents and private and Medicaid in-home care consumers. Some Medicaid recipients (mostly in the bottom wealth quartile) switch from in-home care to nursing home attracted by better care offered by nursing homes. Similarly, some households in the second wealth quartile, mostly those with family, move from private in-home care to Medicaid nursing home. Lastly, some individuals (mostly those without family and in the third wealth quartile) who would have entered nursing home as a private payer switch to private in-home care discouraged by the higher nursing home price. In terms of the average hours used, the policy reduces inequality in care by increasing it for the bottom half of the wealth distribution while having a null effect on the other half.

Table 6: Increase in the Medicaid reimbursement rate: effects on household care choices

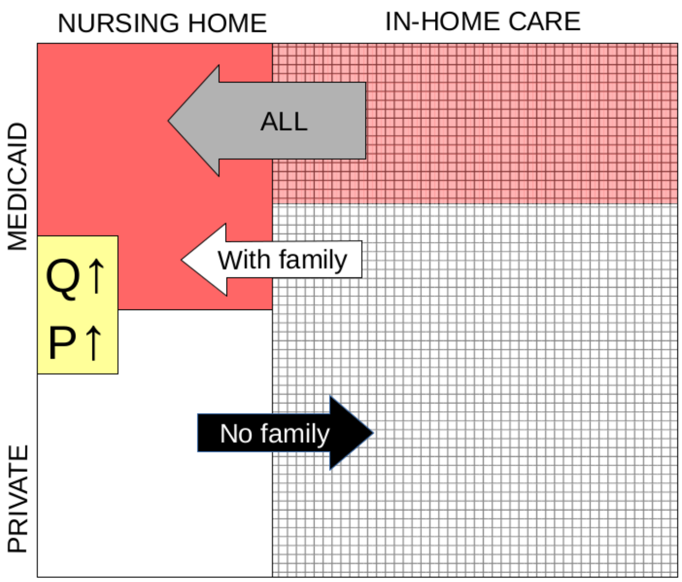
	Care type choice (%)				Mean intensity (hours per year)	
	In-home care		Nursing Home			
	Private	Medicaid	Private	Medicaid	All	Private in-home care
Age: 70-79	62.2	12.9	4.5	20.4	1,889	1,795
	−0.2	−0.4	0.0	+0.6	+16	−1
Age: 80-89	61.2	13.2	5.1	20.4	1,962	1,910
	−0.2	−0.5	−0.2	+0.7	+16	−2
Age: 90-99	65.8	10.7	6.3	17.2	1,670	1,476
	0.0	−0.4	−0.2	+0.6	+12	−5
With family	65.9	12.5	2.8	18.9	1,925	1,865
	−0.3	−0.3	0.0	+0.7	+15	0
Without family	53.1	11.8	13.9	21.3	1,559	1,126
	+0.4	−0.6	−0.4	+0.6	+14	−10
Wealth: Q1	33.6	23.9	0.0	42.6	1,447	269
	0.0	−1.2	0.0	+1.2	+28	−1
Wealth: Q2	65.0	15.4	0.5	19.1	1,123	633
	−0.7	−0.1	−0.1	+0.9	+20	−2
Wealth: Q3	87.1	1.5	9.2	2.1	1,309	1,198
	+0.5	−0.1	−0.6	0.0	+3	−1
Wealth: Q4	82.5	0.0	17.5	0.0	4,288	4,758
	−0.1	0.0	+0.1	0.0	−3	−15

Note: This table includes all individuals whose health is either ADLL or ADLH. The numbers in the highlighted rows show the differences compared to the baseline (the percentage-point differences for the first four columns and the differences in hours for the last two columns).

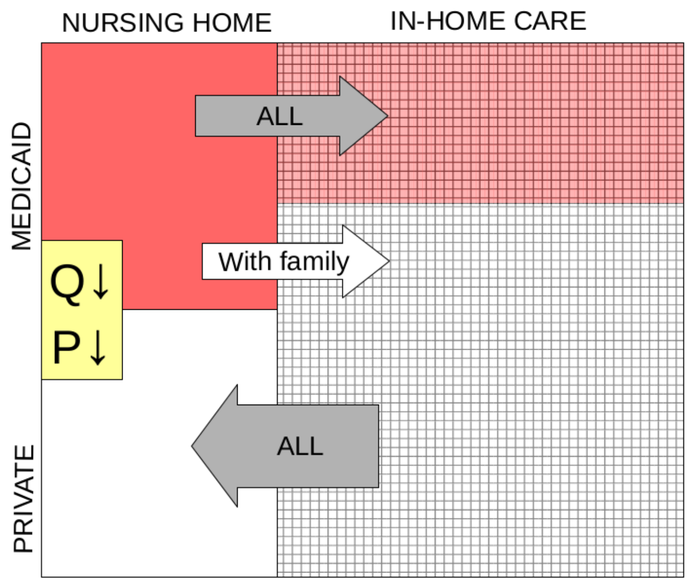
The policy increases the Medicaid expenditure by \$10.9M, which mostly reflects the change in the Medicaid expenditures on nursing-home care (Table 7, Panel A). Given the limited impact on the demand side, the increase in the Medicaid expenditure is mostly absorbed as additional producer surplus (\$8.4M), though the latter is slightly smaller due to the increased cost.[35] The consumer surplus on average increases, but quantitatively it is very small (\$0.4M). Panel B of Table 7 reveals why the increase in consumer surplus is limited. Those who are more likely to be a Medicaid patient at some point—bottom three wealth quartiles—benefit from the higher nursing home care intensity, while those who are

[35] In calculating the total Medicaid expenditure, we take the sum of Medicaid reimbursements to all 11 nursing homes, its expenditure on Medicaid in-home care patients, and the transfers specified in Section 4.1.4. Note that the last item reflects the regulations on the amount of financial resources Medicaid enrollees can keep and thus its value is negative. Regarding the Medicaid in-home care expenditures, due to the lack of direct evidence on how much Medicaid pays for in-home care patients per hour of care (that is comparable to the nursing home care), we assume it to be the same as the Medicaid reimbursement rate for nursing homes in the baseline model (\$76.5K) for those without family support and a half of it for those with family support.

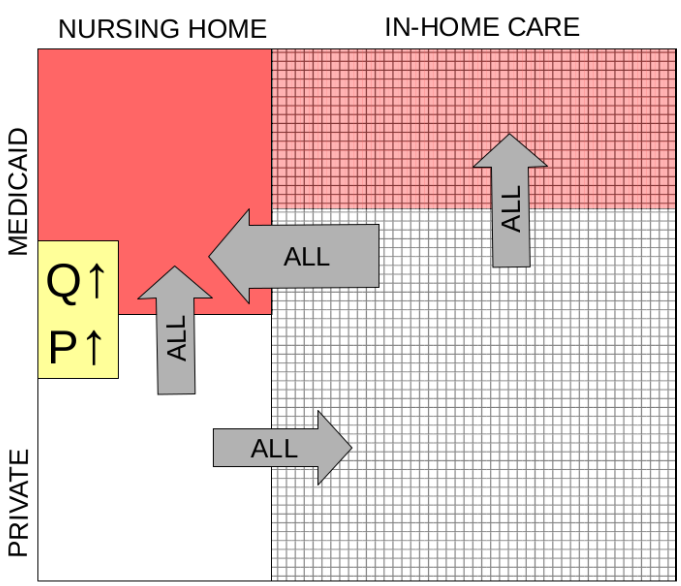
Figure 5: Net care flows



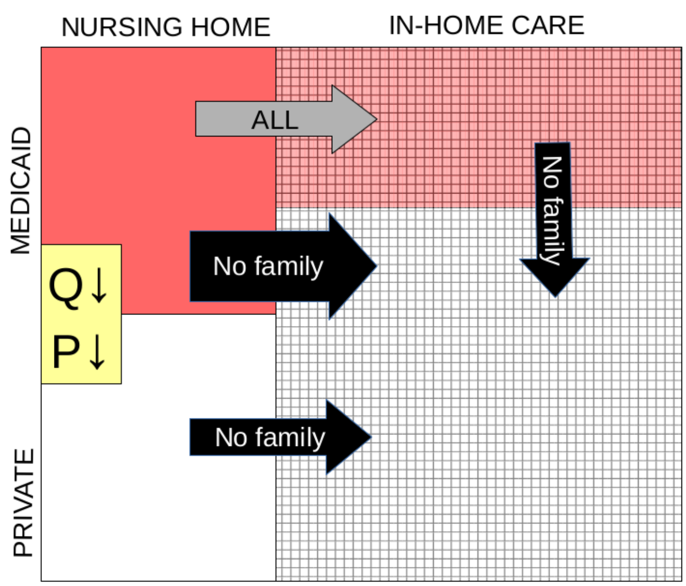
(a) Higher Medicaid reimbursement rate



(b) Entry of a nursing home



(c) Wealth exemption for singles.



(d) In-home care subsidy.

Note: Arrows labeled "No family" represent net flows of individuals with no family help available. Arrows labeled "With family" represent net flows of individuals with family help available. "ALL" refers to individuals with and without family help available. Only significant effects are shown.

more likely to pay for nursing home out of pocket—the top wealth quartile—lose due to the higher price.

Table 7: Supply-side targeted policy experiment: welfare evaluations

A. Aggregates	Increased Medicaid reimbursement rate		Subsidized entry of a NH	
	Δ ($M)	Δ%	Δ ($M)	Δ%
Consumer surplus*	+0.4	NA	+7.2	NA
Producer surplus	+8.4	+37.4	+1.1	+4.9
Medicaid expenditures	+10.9	+11.1	−9.8**	−9.1
Nursing home care	+12.6	+14.1	−16.2	−18.2
In-home care	−1.3	−3.5	+3.2	+8.7
Transfers	−0.4	−0.7	+3.3	+6.0
B. Distribution				
Consumer surplus* by wealth groups	Δlevel (per household, $)		Δlevel (per household, $)	
Wealth: Q1	+52		+221	
Wealth: Q2	+364		-144	
Wealth: Q3	+313		+2,602	
Wealth: Q4	-32		+12,002	

Note: The table presents the changes compared to the values in the baseline model.
* The consumer surplus is calculated as one-time wealth transfers needed to be made to the youngest households (age 70) in the baseline model to give them the same utility as with the policy experiment. The number in Panel A is the summation across households while those in Panel B is the average within each wealth group.
** The change in the Medicaid expenditure in the subsidized NH entry experiment does not include the subsidy paid to a NH to reduce the entry cost.

The welfare losses of some households due to an increase in the equilibrium price can be captured only in a model that explicitly considers the interaction between the supply- and demand-sides in the nursing home market. If we only focused on the direct effect—the increase in the care intensity—then the expected increase in the consumer surplus would have been larger, potentially leading to a conclusion that the increase in the Medicaid reimbursement rate is a cost-effective policy. Our quantitative model, which also captures the incentive of nursing homes to increase the price facing larger demand, in contrast, shows that the policy costs outweigh the benefits.[36]

[36]Note that we assume that the policy does not affect the consumption value of a nursing home stay for a Medicaid patient (Δ_N^M), which is set to be half of the consumption value of a nursing home stay for a private patient (Δ_N^O). If the gap between Δ_N^M and Δ_N^O reflects the public care aversion due to the stigma

6.1.2 Incentivized Entry of a Nursing Home

In the baseline model equilibrium, there are 11 nursing homes, and each nursing home has an annual profit of \$2M after accounting for the annual fixed cost of operation. Equilibrium requires that the entry cost is large enough to discourage entry of another nursing home. Limited local competition results in high price of a nursing home bed and other distortions due to the market power. If Medicaid or other government programs cover the entry cost, however, it is possible to have an entrant that would increase market competition. Following Hackmann (2019), we consider the effect of having a directed entry of a nursing home.[37]

The direct impact of the policy is primarily on the supply side: Nursing homes face less demand as the pool of patients is shared with the entrant. The direct effect is also present on the demand side: A higher number of nursing homes increases the likelihood of finding a better match (i.e., they now take the largest draw from twelve, instead of eleven, draws of preference shocks, ξ^j, $j \in \{\aleph, J+1, \aleph\mathcal{M}, (J+1)\mathcal{M}\}$).

The nursing homes react to the reduced demand by changing their care intensity and prices. The impact of the increased demand on both intensity and price is theoretically ambiguous. As shown in Section 3.2, the incentives to change quality and price are determined by three channels: the slopes of the Medicaid and private demands, the marginal profit on each type of bed and the marginal cost of extra intensity.

On the one hand, sharing the resident pool with more nursing homes means that the slopes of both the Medicaid demand and private demand over intensity ($\frac{\partial m_j}{\partial Q_j}$ and $\frac{\partial n_j}{\partial Q_j}$ in equation (22)) are smaller, reducing incentives to provide higher quality. On the other hand, having fewer residents lowers marginal costs ($\mathcal{C}_N$ and $\mathcal{C}_Q$) which increases incentives to provide higher intensity. Similarly, there are counteracting incentives for the price changes: The smaller number of out-of-pocket patients (n_j) and the smaller marginal cost of bed ($\mathcal{C}_N$) reduce the return to a higher price, while the smaller slope of demand over price ($\frac{\partial n_j}{\partial P_j}$) reduces the marginal cost of increasing the out-of-pocket price (see equation (21)). Reflecting this theoretical ambiguity, the effect of new entrant on price and intensity of nursing home care in Hackmann (2019) varies across counties considered.

Our quantitative model shows that nursing homes reduce both care intensity and price: The last two columns in Table 5 show that intensity goes down by 155 hours per year (-7.3%) and price declines by \$4.1K (-10.7%). Lower care intensity further reduces the Medicaid

effect and if the policy removes such stigma, the increase in the consumer surplus could be larger. If the gap reflects the actual difference in the amenities provided to the two types of patients and if the policy removes such a difference by making nursing homes provide more amenities to Medicaid residents, then a part of the producer surplus in Table 7 would be captured as the consumer surplus.

[37]Unlike Hackmann (2019), who considered a subsidized entry of a public nursing home, we consider a private nursing home entry.

demand faced by each nursing home, resulting in a big loss of Medicaid residents (18.4% or 19.5 beds per nursing home). The number of private residents actually increases (13.8% or 4.3 beds per nursing home) due to the lower price. In the end, each incumbent nursing home has, on average, 15 fewer patients (an 11% loss). Therefore, the subsidized entry of a nursing home makes the incumbents smaller, cheaper, and with lower care intensity. The reduction in profits is limited (3.9%), as the fall in the revenue is accompanied by a similar fall in costs.

Table 8: Subsidized entry of a nursing home: effects on household care choices

	Care type choice (%)				Mean intensity (hours per year)	
	In-home care		Nursing Home			
	Private	Medicaid	Private	Medicaid	All	Private in-home care
Age: 70-79	62.9	14.2	5.4	17.5	1,826	1,779
	+0.5	+0.9	+0.9	−2.3	−47	−17
Age: 80-89	61.4	14.6	6.6	17.4	1,911	1,915
	+0.0	+0.9	+1.3	−2.3	−35	+3
Age: 90-99	64.6	12.2	8.3	15.0	1,639	1,497
	−1.2	+1.2	+1.8	−1.7	−19	+16
With family	66.9	13.6	3.5	16.0	1,868	1,847
	+0.7	+0.8	+0.7	−2.2	−42	−18
Without family	49.1	14.0	17.9	19.0	1,543	1,185
	−3.6	+1.6	+3.6	−1.7	−2	+49
Wealth: Q1	33.3	28.4	0.0	38.3	1,365	271
	−0.3	+3.3	0.0	−3.1	−54	+1
Wealth: Q2	67.4	15.9	1.3	15.4	1,050	630
	+1.7	+0.4	+0.7	−2.8	−53	−5
Wealth: Q3	84.8	0.8	13.7	0.8	1,296	1,196
	−1.8	−0.8	+3.9	−1.3	−10	−3
Wealth: Q4	81.0	0.0	19.0	0.0	4,297	4,871
	−1.6	0.0	+1.6	0.0	+6	+98

Note: This table includes all individuals whose health is either ADLL or ADLH. The numbers in the highlighted rows show the differences compared to the baseline (the percentage-point differences for the first four columns and the differences in hours for the last two columns).

The additional nursing home does not simply absorb residents from other nursing homes, but creates reallocation of households across the types of care. Moreover, as Figure 5b and Table 8 show, the households move in both directions: to and from institutional care. Some nursing home residents from the bottom half of the wealth distribution free Medicaid nursing home beds and become in-home care consumers discouraged by the lower care intensity, with the poorest quartile going to Medicaid in-home care and the second quartile, those with family help in particular—to private in-home care. On contrary, the LTC recipients who are older than 90, have no family, and in the top half of the wealth distribution switch from private in-home care to private nursing home. The average hours of LTC decrease mostly due to the reduced intensity of the NH care. At the same time, the inequality in care consumption increases as the reduction is concentrated in the bottom two wealth quartiles while those in the top two wealth quartiles experience almost no change.

Not surprisingly, higher competition increases the consumer surplus. The last two columns in Table 7, Panel B, show that the additional surplus is large, amounting to \$7.2M. The gain is mostly driven by new nursing home residents in the top two wealth quartiles, who benefit from both the lower nursing home price and the larger selection of nursing homes. The Medicaid nursing home leavers, located in the bottom two wealth quartiles, gain virtually nothing, with the loss from the lower intensity of NH care mitigated by other LTC options as well as the larger selection of nursing homes.

The producer surplus also increases. While each incumbent loses \$0.08M, the entrant gains a profit of \$1.95M, resulting in an overall increase in producer surplus by \$1.1M. The unobserved entry cost makes it difficult to judge the efficiency of this policy. If we do not take into account the entry cost, the total Medicaid expenditure decreases significantly, by \$9.8M. Most of this cost saving is because Medicaid enrollees reallocate from Medicaid nursing home to Medicaid in-home care, which is cheaper for Medicaid if recipients have family support, and some of individuals with family leave Medicaid altogether to use in-home care out of pocket. As a result, the Medicaid expenditures on the nursing-home care declines by $\$16.2M$ while its expenditures on in-home care increases only by $\$3.2M$. Therefore, whether this policy is cost effective or not depends on how the entry cost compares to the total gain (\$18.1M).

To sum up, stronger competition induced by the subsidized entry of a nursing home reduces markups and increases the number of beds provided to the out-of-pocket residents. At the same time, as nursing homes react to the changed demand by reducing the intensity of care, the total number of beds used by the Medicaid residents decreases even with more nursing homes. The reaction of nursing homes causes distributional effects that favor wealthier households. These distributional effects, as well as the fixed cost of entry, should be taken into account when evaluating such policies.

6.2 Demand-Side Targeted Policy Experiments

There is a large literature evaluating effects of Medicaid means-tested subsidies on households savings and welfare (e.g., De Nardi et al., 2010, Kopecky and Koreshkova, 2014, De Nardi et al., 2016, Braun et al., 2017, and Achou, 2020) as well as LTC choice (Grabowski and Gruber, 2007, Mommaerts, 2018).

Following this literature, we study two policies that target the demand-side of the market: *(i)* an increase in Medicaid generosity by allowing single Medicaid residents to keep some wealth, and *(ii)* giving in-home care subsidies to those who do not have family. The main difference between the two policies is that the former affects only the Medicaid enrollees while the latter is not means-tested and applies to everyone who uses in-home care without access to family help.

6.2.1 Medicaid Wealth Exemption for Singles

In the baseline model, singles who become Medicaid recipients are not allowed to keep any significant amount of financial resources or home equity, following the current Medicaid eligibility criteria. De Nardi et al. (2011) and Warshawsky and Marchand (2017) show that, when it comes to the estate recovery, enforcement of this regulation appears to be limited. Based on this observation, Achou (2020) studies how strict enforcement of estate recovery affects the welfare of older households. Motivated by this literature, we now examine how increasing Medicaid generosity, in the form of allowing single Medicaid recipients to keep wealth up to $20K,[38] affects the nursing home market. All single Medicaid enrollees are eligible for this partial wealth exemption regardless of whether they use in-home care or nursing home care.

The direct impact of this policy change is on the demand side: It increases the number of Medicaid recipients among the singles. In particular, many of those who have not chosen to be on Medicaid but could not afford to enter a nursing home as private residents in the baseline model—hence ended up using limited hours of care under out-of-pocket in-home care—will now be Medicaid nursing home residents (see Section 3.1). In the absence of reactions from the nursing homes, the number of Medicaid residents at nursing homes would increase by 24.3%.[39] This results in $0.3M increase in the profit of each nursing home, or $3.3M increase in the total producer surplus.

Before reporting the reaction of the nursing homes to the policy, it is important to layout the nursing home incentives. As shown in Section 3.2, with almost no direct policy effect on the private demand, the price unambiguously increases. The policy effect on care intensity is ambiguous. The slope of Medicaid demand with respect to intensity ($\frac{\partial m_j}{\partial Q_j}$), which affects the marginal return to raising intensity, changes through two channels: by changing the marginal individuals between the Medicaid nursing home and the in-home care option and

[38] $20K is slightly less than half of the median home equity that couples on Medicaid keep in the HRS data.

[39] Its direct impact on the number of private residents is limited. It goes up by 1.9%. This increase comes from the better insurance provided by a more generous Medicaid—hence households have an incentive to spend their resources more quickly by entering a nursing home out of pocket.

by expanding the pool of Medicaid residents that nursing homes are competing over. The effect of the former channel is theoretically ambiguous (see Section 3.1, Proposition 4 (3)), while the effect of the latter channel unambiguously increases the slope. At the same time, a larger number of Medicaid patients increases the marginal costs ($\mathcal{C}_N$ and $\mathcal{C}_Q$), reducing the incentive to increase the intensity.

In our quantitative model, nursing home competition over the expanded pool of Medicaid residents dominates other channels, so the care intensity increases significantly, by 134 hours per year or 6.7% (Table 9). As expected, the price increases and by a lot — $11K or 12.9%. The large inflow of the Medicaid residents, 36.6 individuals per facility or 34.5% (nearly a third larger than the direct impact) outweighs the outflow of private residents: 7.9 individuals per facility or 22.1%. As a result, each nursing home ends up with nearly 30 more residents and a higher share of Medicaid beds (85% versus 77%). Higher number of residents drives the marginal cost up by 10.1%. While the markup on a private resident increases, the profit margin on a Medicaid bed shrinks. Although the total revenue from Medicaid beds increases by more than a third, nursing home profits decline by a small amount ($0.06M or 3%).

Table 9: Demand-side targeted policy experiment: effects on a nursing home

	Baseline	Medicaid Wealth Exemption		In-home care subsidy	
		Δ	Δ%	Δ	Δ%
NH care intensity (Q, hours per year)	2,000	+134	+6.7	−155	−7.7
NH price (P, $K)	85.0	+10.9	+12.9	−3.9	−4.5
Marginal cost ($K)	69.2	+7.0	+10.1	−5.9	−8.5
Private residents	31.2	−6.9	−22.1	−3.0	−9.6
Medicaid residents	106.2	+36.6	+34.5	−13.6	−12.8
NH private revenue ($M)	2.65	−0.32	−12.1	−0.36	−13.6
NH Medicaid revenue ($M)	8.13	+2.79	+34.3	−1.05	−12.9
NH Profits ($M)	2.03	−0.06	−3.0	+0.06	+3.0
NH residents on Medicaid (%)	77	+8	+10.4	0	−0.5

Who fills up the new Medicaid beds? Figure 5c and Table 10 show that the new nursing home residents are coming from all but the top wealth quartile (with larger numbers of new residents at the bottom). First, some Medicaid recipients switch from in-home care to Medicaid nursing home attracted by its higher intensity. Second, some of singles who were paying for care out of pocket become Medicaid enrollees with more wealth allowed to be kept under Medicaid.[40] The switch from private in-home care to Medicaid-paid care is concentrated in the second wealth quartile while that from private nursing home to Medicaid

[40] Note that many of these singles have a child nearby, which makes them classified as "with family" in Table 9. That is why the share of Medicaid enrollees increases among the individuals with family help.

is concentrated in the third wealth quartile. Lastly, those at the top wealth quartile, who would not choose Medicaid even at higher generosity, switch from nursing home to in-home care due to the higher nursing home price. The average consumption of care hours also increases significantly, especially for the two bottom wealth quartiles, reducing the inequality in care.

Table 10: Partial Medicaid wealth exemption for singles: effects on household care choices

	Care type choice (%)				Mean intensity (hours per year)	
	In-home care		Nursing Home			
	Private	Medicaid	Private	Medicaid	All	Private in-home care
Age: 70-79	57.6	14.1	3.7	24.7	2,019	1,967
	−4.8	+0.8	−0.8	+4.9	+146	+171
Age: 80-89	54.6	15.1	4.2	26.1	2,109	2,125
	−6.8	+1.4	−1.1	+6.4	+163	+213
Age: 90-99	56.7	13.3	5.0	25.0	1,850	1,664
	−9.1	+2.3	−1.5	+8.3	+192	+183
With family	58.2	14.6	2.1	25.1	2,090	2,092
	−8.0	+1.8	−0.7	+6.9	+180	+227
Without family	49.2	13.1	11.5	26.3	1,674	1,233
	−3.5	+0.7	−2.8	+5.6	+129	+97
Wealth: Q1	22.1	24.9	0.0	53.0	1,677	218
	−11.5	−0.2	0.0	+11.6	+258	−52
Wealth: Q2	54.7	19.4	0.2	25.7	1,307	670
	−11.0	+3.9	−0.4	+7.5	+204	+35
Wealth: Q3	85.5	3.2	7.0	4.4	1,385	1,262
	−1.1	+1.6	−2.8	+2.3	+79	+63
Wealth: Q4	84.9	0.0	15.1	0.0	4,350	4,745
	+2.3	0.0	−2.3	0.0	+59	−28

Note: This table includes all individuals whose health is either ADLL or ADLH. The numbers in the highlighted rows show the differences compared to the baseline (the percentage-point differences for the first four columns and the differences in hours for the last two columns).

This is a costly policy to implement. Medicaid expenditure increases by $25.8M (Table 11, Panel A). This is driven by an increase in the Medicaid recipiency by single households, in particular by those in the nursing homes.[41] This policy results in a small reduction in the producer surplus (-$0.6M) and a relatively large increase in the consumer surplus (+$13.4M). However, the total surplus gain amounts only to a half of the increase in the Medicaid expenditure. The gains in the consumer surplus are not equally distributed across the households. The households in the second wealth quartile gain the most, as these are

[41] Regarding the transfers, Medicaid allows each single recipient to keep more wealth, but the increase in the number of Medicaid enrollees more than offsets the change in the exemption, resulting in a larger amount of financial resources collected (i.e., a more negative total transfer).

more likely to enter Medicaid when allowed to keep some of their wealth under the new policy. The gain at the top wealth quartile is limited. Though they value higher Medicaid insurance for situations with scant financial resources and no family support, they are less likely to be in such situations than the other wealth groups and are hurt by higher price of nursing homes.

Table 11: Demand-side targeted policy experiment outcomes: welfare evaluations

A. Aggregates	Medicaid Wealth Exemption		In-home care subsidy	
	Δlevel ($M)	Δ%	Δlevel ($M)	Δ%
Consumer surplus*	+13.4	NA	+3.6	NA
Producer surplus	−0.6	−3.0	+0.6	+3.0
Medicaid expenditures	+25.8	+26.2	−2.7	−2.7
Nursing home care	+31.1	+34.9	−11.2	−12.6
In-home care	+4.0	+10.8	+1.7	+4.6
Transfers	−9.4	−17.0	+6.8	+12.3
B. Distribution				
Consumer surplus* by wealth groups	Δlevel (per household, $)		Δlevel (per household, $)	
Wealth: Q1	+4,412		+437	
Wealth: Q2	+11,368		+1,125	
Wealth: Q3	+9,986		+3,092	
Wealth: Q4	+1,624		+2,756	

Note: The table presents the changes compared to the values in the baseline model.
* The consumer surplus is calculated as one-time wealth transfers needed to be made to the youngest households (age 70) in the baseline model to give them the same utility as with the policy experiment. The number in Panel A is the summation across households while those in Panel B is the average within each wealth group.

In short, allowing singles to keep some amount of wealth while being on Medicaid is a costly policy, which does not seem to be justified by efficiency alone. The policy also creates significant distributional effects. Though the direct impact of the policy is on the demand side, the reactions of nursing homes to the changing demand are important in shaping the distributional effects. The expanding pool of Medicaid patients would increase the profits of nursing homes in the absence of their reactions. However, competition among nursing homes on care intensity results in lower profits. Nursing home response, on the other hand, makes the new equilibrium favor poorer individuals as they enjoy more care hours without having to give up all of their financial resources, while the higher price disadvantages wealthier households.

6.2.2 Subsidies for Home-and-Community Based Care

For individuals without family support, one big obstacle for using in-home care is the fixed cost of outsourcing home production as the adverse health condition does not allow them to perform basic home production (Achou, 2016). In our model, this cost is captured by Ξ and is set to be \$20K per year. This cost steers individuals without family away from using in-home care as a private patient. As a result, these individuals end up being Medicaid recipients and consuming amounts of care which largely exceeds the levels they would have demanded as a private in-home care patient in the absence of the fixed cost, thus increasing Medicaid outlays. In this subsection, we consider a policy where the government provides a lump-sum payment to cover half of the in-home care fixed cost (\$10K) to any non-Medicaid user of in-home care.

The direct impact of this policy is on the demand side, which reduces demand for nursing home care as individuals without family leave the nursing home market for the subsidized out-of-pocket in-home care. In the absence of reactions from the nursing homes, about 3 private residents (10.4%) and 4.3 Medicaid residents (4.4%) would leave each nursing home. Lost residents would reduce the profits of each nursing home by \$0.16M.

How do nursing homes respond to the drop in demand? Theoretically, the effects on both price and care intensity are ambiguous. The channels governing nursing home incentives in response to the increased competition from in-home care are similar to the case of a subsidized entry of a nursing home, discussed in Section 6.1.2. The main difference is in the direct effect on the private demand for care. While a nursing home entry makes the nursing home option more attractive, the opposite is true for the cheaper in-home care. Hence, it is not surprising that the effects of the two experiments are qualitatively similar up to the change in the number of the private nursing home residents and associated revenues and profits.

The last two columns of Table 9 show that the care intensity declines by 155 hours per year (-7.7%) and price drops by \$3.9K (-4.5%). Lower care intensity encourages more Medicaid nursing home residents to leave, bringing the total loss to 13.6 individuals (-12.8%). On the contrary, lower price slightly reduces the loss of the private residents to 9.6%. The lower quality and the smaller number of residents reduce the marginal cost by \$5.9K, resulting in a higher profit on each resident. Though revenue from both private and Medicaid residents fall significantly (-13.6% and -12.9%, respectively), profits increase slightly (3%).

Figure 5d and Table 12 show that the new users of private in-home care come primarily from individuals without family of all ages and all wealth quartiles, with most leaving Medicaid beds in nursing homes. While individuals in the bottom quartile switch primarily to Medicaid in-home care, those in wealth quartiles 2 and 3 switch primarily to private in-home care. The mean hours of in-home care do not increase much for the individuals without family support: While those who chose this option in the baseline now can afford more hours, those who switch from Medicaid options to this option under the subsidy tend to be poorer so consume fewer hours of care than the former group. The average intensity of care used declines except for the top wealth quartile, reflecting a switch to out-of-pocket in-home care, where individuals tend to have lower care intensity than in a nursing home except for at the top wealth quartile, as well as the lower intensity of nursing home care than in the baseline.

Table 12: In-home care subsidy: effects on household care choices

	Care type choice (%)				Mean intensity (hours per year)	
	In-home care		Nursing Home			
	Private	Medicaid	Private	Medicaid	All	Private in-home care
Age: 70-79	63.7	14.5	4.3	17.6	1,836	1,795
	+1.3	+1.2	−0.2	−2.2	−37	−1
Age: 80-89	63.3	14.6	4.8	17.3	1,906	1,905
	+1.9	+0.9	−0.5	−2.4	−40	−7
Age: 90-99	68.5	11.5	5.8	14.2	1,611	1,478
	+2.7	+0.4	−0.7	−4.0	−47	−3
With family	66.8	14.1	2.7	16.4	1,882	1,867
	+0.6	+1.3	−0.1	−1.8	−28	+2
Without family	59.3	11.8	12.4	16.5	1,459	1,162
	+6.4	−0.6	−1.9	−4.2	−86	+26
Wealth: Q1	34.8	27.7	0.0	37.5	1,346	289
	+1.2	+2.6	0.0	−3.9	−73	+17
Wealth: Q2	68.0	16.2	0.6	15.3	1,044	630
	+2.3	+0.7	0.0	−2.9	−59	−5
Wealth: Q3	90.0	0.8	8.6	0.9	1,267	1,199
	+3.4	−0.8	−1.2	−1.2	−39	0
Wealth: Q4	83.9	0.0	16.2	0.0	4,338	4,818
	+1.3	0.0	−1.2	0.0	+47	+45

Note: This table includes all individuals whose health is either ADLL or ADLH. The numbers in the highlighted rows show the differences compared to the baseline (the percentage-point differences for the first four columns and the differences in hours for the last two columns).

The last two columns in Table 11, Panel A, indicate that the consumer surplus increases by $3.6M. Similar to the more generous Medicaid experiment, all wealth quartiles gain from the subsidy to in-home care (Panel B). However, the welfare gains are concentrated in the top half of the wealth distribution, who are more likely to use the out-of-pocket in-home care and nursing home, benefiting from their lower costs.

Perhaps somewhat surprisingly, the increase in the consumer surplus comes with no extra expenditures on the government program. In fact, Medicaid outlays,[42], net of the cost of the

[42] We include the expenditure for the in-home care subsidy in the Medicaid expenditure for the ease of comparison with other experiments, though the subsidy might be administered through other government

new program decline by \$2.7M. Though the government is now subsidizing \$10K for each household without family that uses in-home care out of pocket, by doing so, at the same time, it reduces the number of more costly Medicaid nursing home residents, saving $\$11.2M$ on the nursing home care.

This policy experiment shows that the fixed cost of using in-home care without family support is an important barrier that nudges households to use forms of LTC that are much costlier from the viewpoint of society. By reducing the barrier to the more efficient form of LTC, the considered policy both saves the expenditures of the government programs and improves the welfare of consumers.

6.3 LTSS Policy Effects on the Non-care Consumption

The welfare effects reported above arise not only due to the changes in the allocation of care but also due to the changes in the allocation of consumption across individuals and their life cycle. As the policies change the cost and value of each care option, they influence the LTC expense and consumption risks and, hence, household precautionary savings. Being able to consume more when they are not yet sick, can be another important mechanism for households' welfare changes. To study the changes in the precautionary savings, we follow the approach of De Nardi et al. (2016) to compute changes in household consumption at a fixed age. Examining households at the youngest age in our model (age 70) allows us to obtain the effect on consumption solely due to the change in an LTSS policy and not due to the change in the level of accumulated wealth. [43]

Not surprisingly, the consumption responds more to the policies targeting the demand side. For the partial wealth exemption for the singles, households in the middle two wealth quartiles as well as those who do not have family help increase their consumption significantly, by about 2 % of the baseline consumption. Being allowed to keep some wealth as a single Medicaid enrollee makes them more likely to choose this option in the future, thus reducing their precautionary savings. Note, however, that households in the bottom wealth quartile save more. For those who are almost sure to use Medicaid even in the baseline model, being able to keep some wealth while using the Medicaid option reduces their motivation to spend down their wealth before needing care. The in-home care subsidy to individuals without family help reduces precautionary savings of this group. In terms of wealth percentiles, the consumption increase is larger for the top three wealth quartiles, who are more likely to use the out-of-pocket in-home care. Comparison with Table 11 reveals that the pattern of

programs.

[43] Consumption changes at higher ages confound changes in the policy function and that in the amount of savings.

Table 13: Changes in the non-care consumption at age 70

A. Consumption change in dollars

	Baseline	Change in consumption ($)			
		Increased Medicaid reimbursement rate	Subsidized entry of a NH	Medicaid wealth exemption	In-home care subsidy
With family	42,009	+26	−46	+257	+59
Without family	38,268	−17	+180	+680	+437
Wealth: Q1	16,908	+2	−8	−295	+29
Wealth: Q2	27,226	+31	+5	+556	+94
Wealth: Q3	40,207	+47	−175	+858	+162
Wealth: Q4	74,426	−9	−156	+165	+204

B. Consumption change in percent

		Change in consumption (%)			
		Increased Medicaid reimbursement rate	Subsidized entry of a NH	Medicaid wealth exemption	In-home care subsidy
With family		+0.06	−0.11	+0.61	+0.14
Without family		−0.04	+0.47	+1.78	+1.14
Wealth: Q1		+0.01	−0.05	−1.74	+0.17
Wealth: Q2		+0.11	+0.02	+2.04	+0.35
Wealth: Q3		+0.12	−0.44	+2.13	+0.40
Wealth: Q4		−0.01	+0.21	+0.22	+0.27

Note: This table includes all households at age 70 that do not need long-term care.

consumption increase over wealth quartiles is similar to the pattern of welfare gain, suggesting that the reduction in the precautionary savings is an important channel for the welfare gains.

Though the size of the impact is smaller, consumption also reacts to changes in price and intensity of nursing home care from the policies that target the supply-side. The higher nursing-home care intensity arising from the more generous Medicaid reimbursement rate makes the Medicaid nursing home option more attractive and, thus, reduces the precautionary saving of the households in the middle two wealth quartiles. The cheaper nursing home price arising from a subsidized entry of a nursing home reduces precautionary savings of the households in the top wealth quartile, while its lower care intensity induces the households in the third wealth quartile to use out-of-pocket in-home care instead of Medicaid nursing home, thereby increasing their savings.

7 Conclusion

In this paper, we develop a structural model of a nursing home market that explicitly captures the LTC choice by households on the demand side and the choice of intensity and price of care by nursing homes on the supply side. The policy experiments considered in this paper show that to correctly evaluate the efficiency and distributional effects of policies, it is important to take into account the interaction between the demand and supply sides of the market. We show that whether the policy targets supply or demand side, both households and nursing homes' decisions are affected. Taking both responses into account results in much different equilibrium allocation of care and welfare gains or losses relative to the case when one side of the market is fixed. The structural model we develop should be useful for evaluating potential outcomes of a wide range of LTSS policies, especially those for which empirical evidence of effectiveness does not exists.

Although our framework is a step forward in the analyses of LTSS policies, we recognize its limitations and plan to address them in the future. Although our model captures rich heterogeneity on the household side—in age, income, wealth, health, and family status—for tractability, we abstracted from the heterogeneity on the nursing home side. Extending this model to incorporate policy-relevant nursing home heterogeneities—e.g., for-profit versus non-profit (Hackmann, 2019), high-end versus low-end—will be an important next step. Specialization of nursing homes between high-end and low-end—in terms of care intensity or amenities—may alleviate the key disadvantage of nursing home care by providing more flexibility to this option. It is therefore important to study how the policies considered in this paper affect nursing homes' incentives to specialize. Moreover, for the individuals with family nearby, we have taken the availability of family for care duties as given. The response of family to the costs of outside care options may also be important.

References

Achou, Bertrand, "Disability in Retirement, Home Production, and Informal Insurance Between Spouses," *Working Paper*, 2016.

_ , "Housing in Medicaid: Should it Really Change?," *Cahiers de Recherche/Working Paper, Institut sur la Retraite et l'Épargne/Retirement and Savings Insitutue*, 2020, *3.*

Ameriks, John, Andrew Caplin, Steven Laufer, and Stijn van Nieuwerburgh, "The Joy of Giving or Assisted Living? Using Strategic Surveys to Separate Public Care Aversion from Bequest Motives," *Journal of Finance*, 2011, *66*, 519–561.

_ **, Joseph Briggs, Andrew Caplin, Matthew D. Shapiro, and Christopher Tonetti**, "Late-in-Life Risks and the Under-Insurance Puzzle," *Vanguard Research Initiative Working Paper*, 2018.

_ , _ , _ , _ , and _ , "Long-Term-Care Utility and Late-in-Life Saving," *Journal of Political Economy*, forthcoming.

Barczyk, Daniel and Matthias Kredler, "Evaluating Long-Term-Care Policy Options, Taking the Family Seriously," *Review of Economic Studies*, 2018, *85*, 766–809.

_ and _ , "Long-Term Care Across Europe and the U.S.: The Role of Formal and Informal Care," *Fiscal Studies*, 2019, *40*, 329–373.

Braun, Anton, Karen Kopecky, and Tatyana Koreshkova, "Old, Frail, and Uninsured: Accounting for Features of the U.S. Long-Term Care Insurance Market," *Econometrica*, 2019, *87*, 981–1019.

Braun, R. Anton, Koren Kopecky, and Tatyana Koreshkova, "Old, Sick, Alone, and Poor: A Welfare Analysis of Old-Age Social Insurance Programs," *Review of Economic Studies*, 2017, *84*.

Brown, Jeffrey R. and Amy Finkelstein, "The Interaction of Public and Private Insurance: Medicaid and the Long-Term Care Insurance Market," *American Economic Review*, 2008, *98*, 1083–1102.

Butrica, Barbara and Nadia Karamcheva, "The Impact of Informal Caregiving on Older Adults' Labor Supply and Economic Resources," *Urban Institute Report*, 2014.

Ching, Andrew T., Fumiko Hayashi, and Hui Wang, "Quantifying the Impacts of Limited Supply: The Case of Nursing Homes," *International Economic Review*, 2015, *56*, 1291–1322.

De Nardi, Mariacristina, Eric French, and John Bailey Jones, "Why Do the Elderly Save? The Role of Medical Expenses," *Journal of Political Economy*, 2010, *118*, 29–72.

_ , _ , and _ , "Medicaid Insurance in Old Age," *American Economic Review*, 2016, *106*.

_ , _ , _ , and Angshuman Gooptu, "Medicaid and the Elderly," *NBER Working Paper*, 2011, *17689*.

Ettner, Susan L., "The Effects of the Medicaid Home Care Benefit on Long-Term Care Choices of the Elderly," *Economic Inquiry*, 1994, *32*, 103–127.

Genworth, *Cost of Care Survey* 2019. https://www.genworth.com/aging-and-you/finances/cost-of-care.html.

Gertler, Paul J., "Subsidies, Quality, and the Regulation of Nursing Homes," *Journal of Public Economics*, 1989, *38.*

Grabowski, David C., "Medicaid Reimbursement and the Quality of Nursing Homes," *Journal of Health Economics*, 2001, *20*, 549–569.

_ **and Jonathan Gruber**, "Moral Hazard in Nursing Home Use," *Journal of Health Economics*, 2007, *26.*

Hackmann, Martin, "Incentivizing Better Quality of Care: The Role of Medicaid and Competition in the Nursing Home Industry," *American Economic Review*, 2019, *109*, 1684–1716.

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

Johnson, Richard W., Cori E. Uccello, and Joshua H. Goldwyn, "Who Foregoes Survivor Protection in Employer-Sponsored Pension Annuities?," *The Gerontologist*, 2003, *45*, 26–35.

Jones, John, Mariacristina De Nardi, Eric French, Rory McGee, and Justin Kirschner, "The Lifetime Medical Spending of Retirees," *NBER Working Paper*, 2018, *24599.*

Kaiser Family Foundation, *Kaiser Commission on Medicaid and the Uninsured* 2017. https://www.kff.org/infographic/medicaids-role-in-nursing-home-care/.

Ko, Ami, "An Equilibrium Analysis of the Long-term Care Insurance Market," *Working Paper*, 2020.

Kopecky, Karen and Tatyana Koreshkova, "The Impact of Medical and Nursing Home Expenses on Savings," *American Economic Journal: Macroeconomics*, 2014, *6*, 29–72.

Miller, Sarah, Norman Johnson, and Laura R. Wherry, "Medicaid and Mortality: New Evidence from Linked Survey and Administrative Data," *NBER Working Paper*, 2020, *26081.*

Mommaerts, Corina, "Long-Term Care Insurance and the Family," *Working Paper*, 2016.

_ , "Are Coresidence and Nursing Homes Substitutes? Evidence from Medicaid Spend-Down Provisions," *Journal of Health Economics*, 2018, *59*, 125–138.

Nyman, John A., "Prospective and 'Cost-Plus' Medicaid Reimbursement, Excess Medicaid Demand, and the Quality of Nursing Home Care," *Journal of Health Economics*, 1985, *4*.

Stabile, Mark, Audrey Laporte, and Peter C. Coyte, "Household Responses to Public Home Care Programs," *Journal of Health Economics*, 2006, *25*, 674–701.

U.S. Department of Health and Human Services, *How Much Care Will You Need?* 2020. https://longtermcare.acl.gov/the-basics/how-much-care-will-you-need.html.

Warshawsky, Mark J. and Ross A. Marchand, "Improving the System of Financing Long-term Services and Supports for Older Americans," *Journal of Retirement*, 2017, *5*, 48–68.

A Appendix: Estimation of the Health Transition Matrices

We use an approach based on Jones et al. (2018). The transition matrix from the current health state ($h_t \in \{ADLH, ADLL, Fair, Good\}$) to the next period's health state ($h_{t+1} \in \{D, ADLH, ADLL, Fair, Good\}$) is obtained from multinomial logit estimation, which includes a constant, current health, gender, age, age squared, whether single or coupled, the permanent income of households, as well as interactions of these as the control variables. For permanent income, we create quartiles, and we use the dummy variable for each quartile.

To be specific, for each potential transition from $i \in \{ADLH, ADLL, Fair, Good\}$ to $j \in \{D, ADLH, ADLL, Fair, Good\}$, the probability of that event is determined as:

$$\begin{aligned} \pi_{ij,t} &= Pr(h_{t+1} = j | h_t = i) \\ &= \gamma_{ij} / \sum_k \gamma_{ik}, \\ \gamma_{iD} &= 1, \ \ \forall i, \\ \gamma_{ik} &= exp(x_{h_t=i}\beta_k), \ k \in \{ADLH, ADLL, Fair, Good\}, \end{aligned} \tag{27}$$

where $\{\beta_k\}$ is the set of coefficient vectors and $x_{h_t=i}$ is the vector of the control variables with $h_t = i$. We estimate $\{\beta_k\}$ by MLE, using all HRS observations from 2004 to 2014.

We present some examples of the estimated transition matrices in Table A1 (for age 70) and Table A2 (for age 90). Rows represent the current state and columns represent the next period's state. At age 70, a "Good" health is a persistent state and the more so for a female and for those with high permanent income. At age 90, needing help with ADLs or death two years later becomes much more likely, even conditional on being "Good" in the current period. Table A3 presents the stationary distribution generated from the initial distribution and the estimated health transition matrices. Panel A shows the share of the population by age group. Panels B and C show the distribution of health and family structure conditional on each age group.

Table A1: Health transition matrix: For age 70, coupled

		PI 1st quartile					PI 4th quartile				
		Death	ADLH	ADLL	Fair	Good	Death	ADLH	ADLL	Fair	Good
Male	ADLH	0.190	0.505	0.186	0.079	0.040	0.229	0.399	0.144	0.100	0.128
	ADLL	0.161	0.196	0.326	0.186	0.131	0.107	0.096	0.393	0.132	0.273
	Fair	0.103	0.069	0.107	0.496	0.225	0.096	0.035	0.118	0.433	0.318
	Good	0.036	0.024	0.057	0.137	0.746	0.018	0.010	0.039	0.066	0.867
Female	ADLH	0.158	0.481	0.217	0.115	0.030	0.158	0.478	0.147	0.115	0.102
	ADLL	0.100	0.179	0.329	0.265	0.127	0.059	0.117	0.369	0.159	0.297
	Fair	0.062	0.057	0.146	0.552	0.183	0.054	0.042	0.160	0.435	0.309
	Good	0.023	0.022	0.057	0.140	0.759	0.009	0.011	0.033	0.051	0.896

Table A2: Health transition matrix: For age 90, coupled

		PI 1st quartile					PI 4th quartile				
		Death	ADLH	ADLL	Fair	Good	Death	ADLH	ADLL	Fair	Good
Male	ADLH	0.497	0.417	0.060	0.009	0.017	0.531	0.387	0.048	0.009	0.026
	ADLL	0.412	0.248	0.187	0.057	0.096	0.326	0.191	0.311	0.045	0.126
	Fair	0.293	0.168	0.099	0.233	0.207	0.318	0.133	0.147	0.221	0.180
	Good	0.191	0.133	0.092	0.104	0.480	0.164	0.123	0.126	0.080	0.507
Female	ADLH	0.448	0.434	0.092	0.013	0.013	0.397	0.507	0.064	0.011	0.021
	ADLL	0.291	0.259	0.260	0.093	0.097	0.189	0.248	0.374	0.057	0.132
	Fair	0.197	0.156	0.181	0.293	0.172	0.187	0.165	0.249	0.232	0.166
	Good	0.132	0.132	0.124	0.118	0.494	0.093	0.151	0.146	0.071	0.539

Table A3: Population distribution: Age, health, and family structure

A. Age distribution								
Age group	Share (%)							
70 - 78	50.5							
80 - 88	36.2							
90 - 98	12.7							
100 - 110	0.7							
B. Health distribution (%, by age group)								
	Male				**Female**			
Age group	ADLH	ADLL	Bad	Good	ADLH	ADLL	Bad	Good
70 - 78	5.7	11.3	17.8	65.3	7.1	11.9	15.8	65.2
80 - 88	13.4	16.1	16.4	54.1	16.1	17.4	13.8	52.7
90 - 98	27.9	19.9	12.3	40.0	33.9	24.7	8.3	33.1
100 - 110	50.1	29.4	6.4	14.1	59.0	24.8	2.7	13.5
C. Family structure (%, by age group)								
	Couple	Single, child nearby	Single, no child nearby					
70 - 78	44.1	36.4	19.6					
80 - 88	27.4	46.7	25.8					
90 - 98	10.6	56.3	33.1					
100 - 110	2.1	64.0	33.9					

Note: Panel A shows the share of the population by age group. Panels B and C show the distribution of health and family structure conditional on each age group. The unit of observation is a household for Panels A and C, and an individual for Panel B.

B Appendix: Proofs

B.1 Proof of Proposition 1

Given (ω, P, ρ) the reservation intensity for nursing home care $Q^r = \mathcal{Q}(\omega, P, \rho)$ solves

$$u(Q^r) + v(\omega - P) = u(q) + v(\omega - \rho q) = U^H(\omega, \rho), \tag{28}$$

where $q = g(\omega, \rho)$ is the optimal decision rule for the in-home care intensity, i.e., q solves

$$u'(q) = \rho v'(\omega - \rho q). \tag{29}$$

Totally differentiate (28):

$$u'(Q^r)dQ^r + v'(\omega - P)[d\omega - dP] = v'(\omega - \rho q)(d\omega - qd\rho), \tag{30}$$

to find partial derivatives:

$$\frac{dQ^r}{d\omega} = \frac{\partial \mathcal{Q}(\omega, P, \rho)}{\partial \omega} = \frac{v'(\omega - \rho q) - v'(\omega - P)}{u'(Q^r)}, \tag{31}$$

$$\frac{dQ^r}{dP} = \frac{\partial \mathcal{Q}(\omega, P, \rho)}{\partial P} = \frac{v'(\omega - P)}{u'(Q^r)} > 0, \tag{32}$$

$$\frac{dQ^r}{d\rho} = \frac{\partial \mathcal{Q}(\omega, P, \rho)}{\partial \rho} = -\frac{qv'(\omega - \rho q)}{u'(Q^r)} < 0. \tag{33}$$

(32) and (33) correspond to demand properties with respect to prices in Proposition 1.

To show that the reservation quality is U-shaped in wealth, we first show that $\exists \omega^*$ such that $\frac{\partial \mathcal{Q}(\omega,P,\rho)}{\partial \omega}|_{\omega^*} = 0$, then we show that $\frac{\partial \mathcal{Q}(\omega,P,\rho)}{\partial \omega}|_{\omega<\omega^*} < 0$ and $\frac{\partial \mathcal{Q}(\omega,P,\rho)}{\partial \omega}|_{\omega>\omega^*} > 0$.

First, derive the properties of the optimal decision rule for in-home care intensity by totally differentiating (29):

$$u''(q)dq = v''(\omega - \rho q)[d\omega - \rho dq], \tag{34}$$

to obtain:

$$\frac{dq}{d\omega} = \frac{\partial g(\omega,\rho)}{\partial \omega} = \frac{v''(\omega-\rho q)}{u''(q)} > 0, \tag{35}$$

$$\frac{dq}{d\rho} = \frac{\partial g(\omega,\rho)}{\partial \rho} = -\frac{\rho v''(\omega-\rho q)}{u''(q)} < 0. \tag{36}$$

From (31), $\frac{\partial \mathcal{Q}(\omega,P,\rho)}{\partial \omega} = 0$ iff $q = \frac{P}{q}$. $\exists \omega^*$ that solves $q = \frac{P}{q} = g(\omega^*, \rho)$.

From (35), if $\omega < \omega^*$, then $q = g(\omega,\rho) < \frac{P}{\rho}$, which implies $v'(\omega - \rho q) - v'(\omega - P) < 0$ and hence $\frac{\partial \mathcal{Q}(\omega,P,\rho)}{\partial \omega} < 0$. Similarly, $\frac{\partial \mathcal{Q}(\omega,P,\rho)}{\partial \omega} > 0$ for $\omega > \omega^*$: $q = g(\omega,\rho) > \frac{P}{\rho}$ and $v'(\omega - \rho q) - v'(\omega - P) > 0$.

Q.E.D.

Properties derived at the end of the proof to Proposition 1 will be used in the proof of Proposition 2, so we formalize them in a corollary:

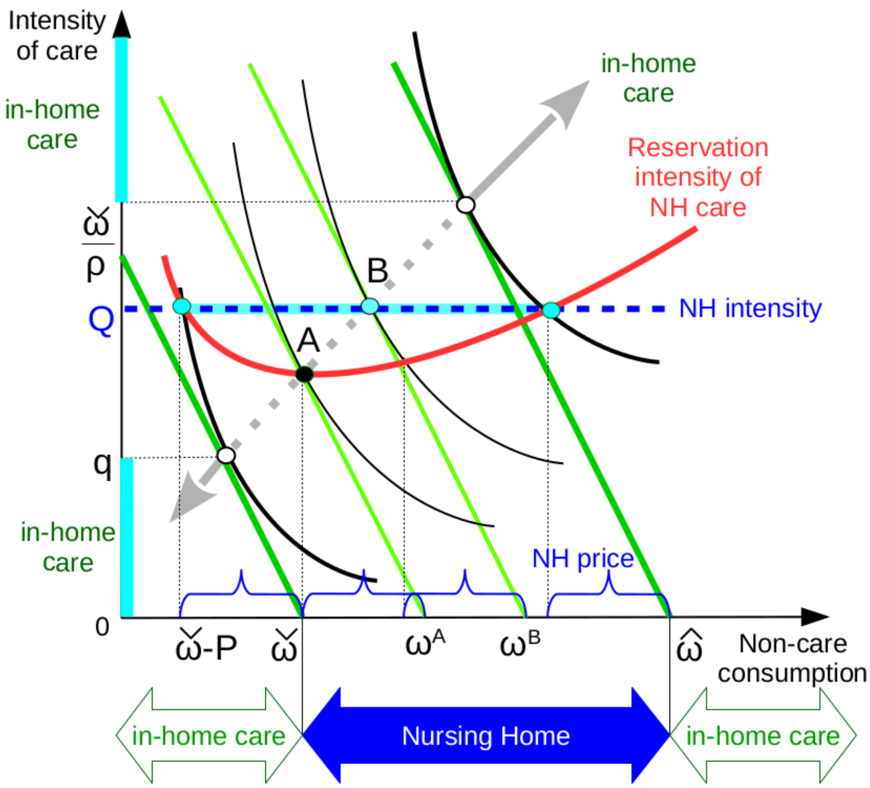
Corollary *There are at most two levels of wealth, $\breve{\omega}$ and $\hat{\omega}$, for which the participation constraint (3) is binding, i.e., $Q = \mathcal{Q}(\hat{\omega}, P, \rho) = \mathcal{Q}(\breve{\omega}, P, \rho)$, and (3) is satisfied for all levels in-between: $Q > \mathcal{Q}(\omega, P, \rho)$ for $\forall \omega \in (\breve{\omega}, \hat{\omega})$ where $\breve{\omega} < \hat{\omega}$. Moreover, the optimal in-home care intensities of the marginal individuals satisfy $\breve{q} \equiv g(\breve{\omega}, \rho) < \frac{P}{\rho} < g(\hat{\omega}, \rho) \equiv \hat{q}$.*

Figure 6 illustrates how the reservation intensity of nursing home care changes with wealth level given nursing home price P in a community of individuals facing the same in-home care price (e.g., single individuals without family support). Each point of the reservation intensity curve is found similarly to Figure 1a: For each level of wealth ω, locate a point with non-care consumption $(\omega - P)$ on the in-home care indifference curve (the participation constraint). For the marginal individuals—those with wealth levels $\breve{\omega}(P, Q|\rho)$ and $\hat{\omega}(P, Q|\rho)$—the participation constraint is binding: $Q = \mathcal{Q}(\breve{\omega}, P, \rho) = \mathcal{Q}(\hat{\omega}, P, \rho)$. Individuals with $\omega \in (\breve{\omega}, \hat{\omega})$ are strictly better off at the nursing home. The reservation intensity for individual with wealth level ω^A is equal to his optimal in-home care intensity, which also corresponds to the minimum of the reservation intensities across the wealth distribution, given care prices P and ρ. Homothetic preferences imply that the minimum of all acceptable intensity levels equalizes the unit price of care: $\mathcal{Q}(\omega^A, P, \rho) = q = \frac{P}{\rho}$. Notice that nursing home intensity exceeds the optimal in-home care intensity for individuals with wealth below ω^B and is below the optimal in-home care intensity for wealthier individuals.

B.2 Proof of Proposition 2

Given a pool of individuals with common ρ_i and a wealth cdf $\Phi_i(\omega)$, $\omega \in [\underline{\omega}, \bar{\omega}]$, for each (P, Q) the private demand for nursing home beds is given by the number of people with satisfied

Figure 6: Wealth margin of the demand for care



participation constraint (3). Let $\breve{\omega}$ and $\hat{\omega}$ denote the wealth of the marginal individuals in this pool, such that $\underline{\omega} < \breve{\omega} < \hat{\omega} < \bar{\omega}$. Given the Corollary to Proposition 1, the private demand can be written as:

$$n_i(P, Q) = \psi_i \left[\Phi_i(\hat{\omega}) - \Phi_i(\breve{\omega})\right]. \tag{37}$$

Derivatives of the private demand are:

$$\frac{\partial n_i}{\partial x} = \psi_i \left[\phi_i(\hat{\omega})\frac{\partial \hat{\omega}}{\partial x} - \phi_i(\breve{\omega})\frac{\partial \breve{\omega}}{\partial x}\right], \text{ for } x = P, \rho, Q. \tag{38}$$

Using (28), find derivatives $\frac{\partial \omega}{\partial P}$, $\frac{\partial \omega}{\partial \rho_i}$, and $\frac{\partial \omega}{\partial Q}$:

$$\frac{\partial \omega}{\partial P} = \frac{v'(\omega - P)}{v'(\omega - \rho_i q) - v'(\omega - P)}, \tag{39}$$

$$\frac{\partial \omega}{\partial \rho} = -\frac{q v'(\omega - \rho q)}{v'(\omega - \rho_i q) - v'(\omega - P)}, \tag{40}$$

$$\frac{\partial \omega}{\partial Q} = \frac{u'(Q)}{v'(\omega - \rho_i q) - v'(\omega - P)}. \tag{41}$$

Using the Corollary to Proposition 1, sign the denominators of the above derivatives for the marginal individuals: $v'(\hat{\omega} - \rho_i \hat{q}) - v'(\hat{\omega} - P) > 0$ and $v'(\breve{\omega} - P) - v'(\breve{\omega} - \rho_i \breve{q}) < 0$. Then the demand derivatives are:

$$\frac{\partial n_i}{\partial P} = -\psi_i \left[\phi_i(\hat{\omega}) \frac{v'(\hat{\omega} - P)}{v'(\hat{\omega} - \rho_i \hat{q}) - v'(\hat{\omega} - P)} + \phi_i(\breve{\omega}) \frac{v'(\breve{\omega} - P)}{v'(\breve{\omega} - P) - v'(\breve{\omega} - \rho_i \breve{q})} \right] < 0, \tag{42}$$

$$\frac{\partial n_i}{\partial \rho} = -\psi_i \left[\phi_i(\hat{\omega}) \frac{\hat{q} v'(\hat{\omega} - \rho_i \hat{q})}{v'(\hat{\omega} - \rho_i \hat{q}) - v'(\hat{\omega} - P)} + \phi_i(\breve{\omega}) \frac{\breve{q} v'(\breve{\omega} - \rho_i \breve{q})}{v'(\breve{\omega} - P) - v'(\breve{\omega} - \rho_i \breve{q})} \right] < 0, \tag{43}$$

$$\frac{\partial n_i}{\partial Q} = \psi_i \left[\phi_i(\hat{\omega}) \frac{u'(Q)}{v'(\hat{\omega} - \rho_i \hat{q}) - v'(\hat{\omega} - P)} + \phi_i(\breve{\omega}) \frac{u'(Q)}{v'(\breve{\omega} - P) - v'(\breve{\omega} - \rho_i \breve{q})} \right] > 0. \tag{44}$$

Q.E.D.

The effect of higher intensity on the demand for nursing home care is illustrated on Figure 7.

B.3 Proof of Proposition 3

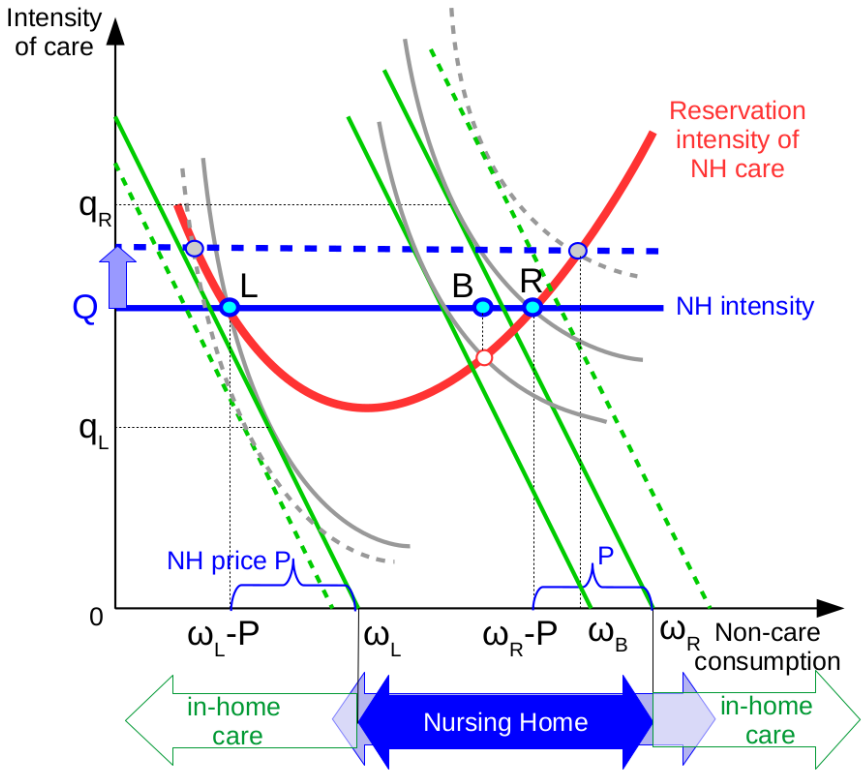
Given a pool of individuals with common ρ_i and a wealth cdf $\Phi_i(\omega)$, $\omega \in [\underline{\omega}, \bar{\omega}]$, for each (Q, c^M) the Medicaid demand for nursing home beds is given by the number of people with satisfied participation constraint (3):

$$U^M(Q, c^M) = u(Q) + v(c^M) \geq u(q) + v(\omega - \rho_i q) = U^H(\omega, \rho_i), \tag{45}$$

where $q = g(\omega, \rho_i)$. Let ω^M denote the wealth of the marginal individual in this pool, i.e., the individual who is indifferent between in-home care and Medicaid nursing home (assuming $\omega^M(Q|c^M, \rho_i) < C^M + P$). Then ω^M solves:

$$u(Q) + v(c^M) = u(q) + v(\omega^M - \rho_i q), \tag{46}$$

Figure 7: Higher intensity of care increases the pool of nursing home residents.



where $q = g(\omega^M, \rho_i)$. Assuming $\omega^M > \underline{\omega}$, Medicaid demand can then be written as

$$m_i(Q|c^M) = \psi_i \Phi_i[\omega^M(Q|c^M, \rho_i)]. \tag{47}$$

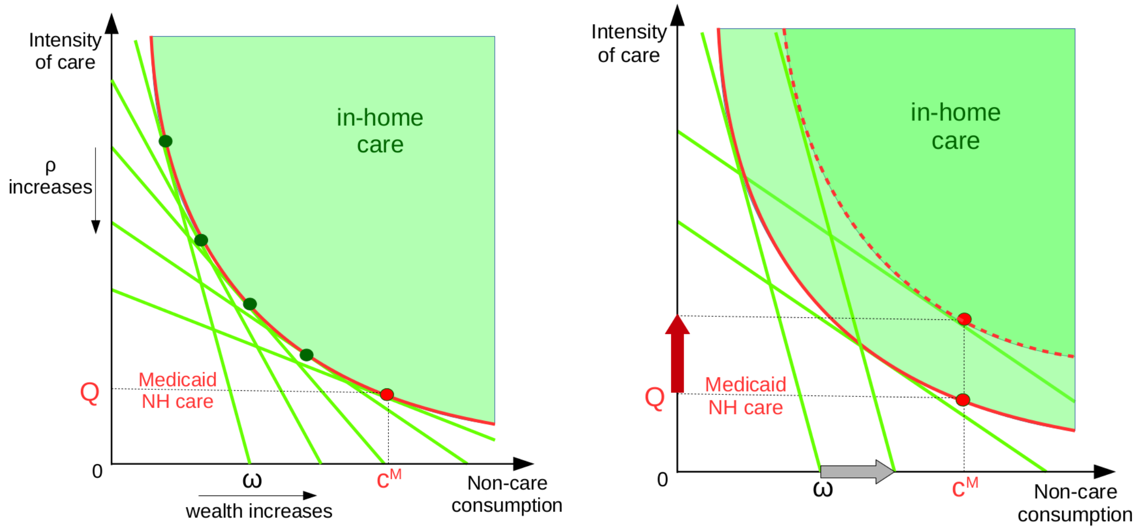
Before proceeding to the properties of the Medicaid demand for nursing home, let's illustrate them graphically. Figure 8a shows the indifference curve corresponding to the utility delivered by the Medicaid stay at the nursing home. The points on the indifference curve correspond to marginal individuals characterized by the combination of their resources and price of in-home care, (ω, ρ). Consider the steepest budget constraint (the lowest in-home care price): Individuals with wealth below ω strictly prefer Medicaid stay at the nursing home to in-home care. As the price of in-home care increases, wealthier individuals switch from in-home care to Medicaid nursing home.

Let q_i be the optimal in-home care intensity of individual of type $i \in \{F, S\}$, with wealth ω_i^M such that $U^H(\omega_i^M, \rho_i) = U^M(Q, c^M)$. We will show that the Medicaid demand of individuals of type $i \in \{F, S\}$ has the following properties:

Figure 8: Choice between in-home care and Medicaid nursing home

(a) Allocation given the intensity of nursing home care

(b) Effects of increase in the intensity of nursing home care



1. *The slope of the demand over intensity is positive:*

$$\frac{\partial m_i}{\partial Q} = \psi_i \phi_i(\omega_i^M) \frac{u'(Q)}{v'(\omega_i^M - \rho_i q_i)} \geq 0. \tag{48}$$

2. *The demand is increasing in the Medicaid generosity (consumption floor):*

$$\frac{\partial m_i}{\partial c^M} = \psi_i \phi_i(\omega_i^M) \frac{v'(c^M)}{v'(\omega^M - \rho_i q_i)} > 0. \tag{49}$$

3. *The slope of the Medicaid demand over intensity increases with the Medicaid generosity if either the density margin is non-negative or the preference margin dominates a negative density margin:*

$$\frac{\partial^2 m_i}{\partial Q \partial c^M} = \frac{\psi_i u'(Q) v'(c^M)}{\left[v'(\omega_i^M - \rho_i q_i)\right]^2} \left[\underbrace{\phi_i'(\omega_i^M)}_{density} \underbrace{-\phi(\omega_i^M) \frac{v''(\omega^M - \rho q_i)}{v'(\omega_i^M - \rho q_i)}}_{preference} \right]. \tag{50}$$

Totally differentiating (46):

$$u'(Q)dQ + v'(c^M)dc^M = v'(\omega^M - \rho_i q)(d\omega^M - qd\rho_i), \tag{51}$$

to find partial derivatives:

$$\frac{\partial \omega^M}{\partial Q} = \frac{u'(Q)}{v'(\omega^M - \rho_i q)} > 0, \tag{52}$$

$$\frac{\partial \omega^M}{\partial c^M} = \frac{v'(c^M)}{v'(\omega^M - \rho_i q)} > 0, \tag{53}$$

$$\frac{\partial \omega^M}{\partial \rho_i} = q > 0. \tag{54}$$

Using (54) and (52), find the demand slopes:

$$\frac{\partial m_i}{\partial Q} = \psi_i \phi_i(\omega^M) \frac{\partial \omega^M}{\partial Q} = \psi_i \phi_i(\omega^M) \frac{u'(Q)}{v'(\omega^M - \rho_i q)} > 0, \tag{55}$$

$$\frac{\partial m_i}{\partial c^M} = \psi_i \phi_i(\omega^M) \frac{\partial \omega^M}{\partial c^M} = \psi_i \phi_i(\omega^M) \frac{v'(c^M)}{v'(\omega^M - \rho_i q)} > 0. \tag{56}$$

Differentiating (55) with respect to c^M and using (56), obtain:

$$\frac{\partial^2 m_i}{\partial Q \partial c^M} = \psi_i u'(Q) \frac{\partial \omega^M}{\partial c^M} \left[\phi_i'(\omega^M) \frac{1}{v'(\omega^M - \rho_i q)} + \phi_i(\omega^M) \frac{v''(\omega^M - \rho_i q)}{[v'(\omega^M - \rho_i q)]^2} \right] \tag{57}$$

$$= \frac{\psi_i u'(Q) v'(c^M)}{[v'(\omega^M - \rho_i q)]^2} \left[\phi_i'(\omega^M) - \phi_i(\omega^M) \frac{v''(\omega^M - \rho_i q)}{v'(\omega^M - \rho_i q)} \right]. \tag{58}$$

Q.E.D.