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

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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 as well as the number of care hours if using in-home care. On the supply side, locally competitive nursing homes decide prices and intensities of care given the household demand. Medicaid provides long-term care to the poorest, but allocating care not based on prices also causes inefficiency. We use our equilibrium model to examine the impacts of various long-term care policies. We find that a lump-sum subsidy to the out-of-pocket cost of in-home care significantly increases households' welfare without a large increase in government expenditure because the policy diverts individuals away from Medicaid-paid care. We show that equilibrium analysis is important for assessing welfare and distributional effects of policies.

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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). The demand for long-term care (LTC) is high: About 70 percent of Americans over the age of 65 develop severe needs for LTC,[2] and over half of the individuals end up using nursing home care (Hurd et al., 2014). LTC is expensive: The annual cost of a nursing home stay in 2019 was over $90K for a semi-private room; in-home care costs $20−$40 per hour (Genworth, 2019). The high out-of-pocket costs force a large share of Americans to rely on public means-tested LTC programs,[3] most importantly Medicaid.[4] On the supply side, nursing home care is mostly delivered by the private sector. According to National Investment Center for Seniors Housing & Care (2018), 57% of the 130-billion-dollar industry revenues came from Medicaid, only a small portion was paid by private insurance, and the rest was paid out of pocket. Since individuals searching for a nursing home do not travel far (Hackmann, 2019), a small number of nursing homes compete in a local market, giving them market power. With this market power, nursing homes adjust the price and intensity of care in response to changes in demand due to public LTC policy changes. Therefore, it is natural to ask: Is modeling the nursing home market important for the analysis of LTC policies? Our answer is *Yes*.

In this paper, we build a dynamic structural model of a nursing home market equilibrium, where both 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-saving decisions, and those with LTC needs choose to receive care either at a nursing home or in their own home. Individuals with low resources qualify for free Medicaid LTC via means tests. On the supply side, locally competitive nursing homes decide the price and intensity of care, taking as given the household demand for beds and the Medicaid reimbursement rate.[5] Medicaid imposes rules on both sides of the market.

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

[2] See U.S. Department of Health and Human Services (2020).

[3] They are formally known as the long-term services and supports programs.

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

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

We obtain the demand for nursing home care by solving life-cycle stochastic dynamic problems of retired households facing uncertainty about their members' health, LTC needs, 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 LTC by modeling nursing home entry and in-home care intensity decisions. While nursing homes provide a fixed intensity of care, households can choose in-home care intensity freely. The out-of-pocket cost of in-home care differs across households: It is relatively low for those with family support—from a healthy spouse or a nearby child—and it is high for those without family support. Moreover, individuals without family face a substantial fixed cost of outsourcing basic home production when using in-home care. The households' care choices give rise to the private and Medicaid demands for nursing home care. While both demands increase with the intensity of care, the price matters only for the private demand.

On the supply side, we solve the static problem of a nursing home competing with other nursing homes in the local market. Each nursing home faces an identical cost structure with respect to the number of beds and intensity of care. A nursing home decides the out-of-pocket price of a 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.[6] We solve for a symmetric Nash equilibrium of the nursing home market.

We discipline the demand-side parameters of the model with micro-evidence on the LTC utilization 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 nursing home usage is U-shaped in wealth. The latter pattern arises because the high out-of-pocket cost of nursing homes implies that it is used primarily by richer individuals or by the poor whose LTC costs are paid by Medicaid. The supply-side

we 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.

[6]Consistently with the Medicaid rules, a nursing home can neither refuse entry to an eligible Medicaid resident nor discriminate on care intensity.

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.[7] Furthermore, we validate the supply side of our model with the equilibrium responses to a change in the Medicaid reimbursement rate and to an incentivized entry of a new nursing home, both of which align well with the estimates from the literature.

We use the quantitative model to evaluate the welfare and distributional effects of two types of LTC policies: (i) subsidies to individuals using out-of-pocket in-home care and (ii) extending/restricting Medicaid generosity for LTC. We show that in both cases, it is important to capture the nursing home responses to the policy.

The first in-home care policy introduces a uniform \$10K subsidy to individuals with no family support. The subsidy induces a number of individuals to switch from Medicaid care to out-of-pocket in-home care, allowing the government to save a large amount on Medicaid enrollees. Not only does the policy significantly increase household welfare, but also it does not cost much—increasing overall welfare. The key behind the welfare gain is that the policy lets households face the marginal cost of care while guaranteeing a certain level of care with a flat subsidy.

Similar principles are shown to be beneficial in a non-LTC setting of Medicaid by Pashchenko and Porapakkarm (2019) and are the basis for conjectures for the efficacy of in-home care subsidies by Arapakis et al. (2022). We show, however, that the benefits of such policies are importantly affected by the equilibrium effects. Facing increased competition with in-home care, nursing homes raise the care intensity to win back residents while also increasing the out-of-pocket price to cover their higher marginal costs. The higher care intensity makes the Medicaid nursing home option more appealing, somewhat offsetting the direct effects of the policy. Nevertheless, in the new equilibrium, this is still a highly welfare-enhancing policy, where the sum of the consumer and producer gains is almost double the increase in Medicaid expenditure. We show that not incorporating nursing home reactions results in a significant overestimate (by more than 60%) of the increase in the overall welfare.

We also examine alternative in-home care subsidies: a flat \$10K subsidy that excludes rich individuals and a proportional subsidy (\$3.5 per hour of care). Total welfare gains from these two alternative forms are not as large as from the uniform in-home care subsidy. Although the phased-out subsidy does save money on households

[7] 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.

who use out-of-pocket in-home care regardless of the subsidy, the insurance value of the subsidy exceeds the cost even for these households. The key pitfall of the proportional subsidy is that it is regressive. Not only does it transfer much more resources to wealthier individuals using many hours of care, but it also fails to provide a meaningful amount of subsidies to those on the margin between Medicaid and out-of-pocket in-home care, limiting the efficacy of the policy.

The second set of LTC policies varies Medicaid generosity by changing the consumption floor for those whose LTC is paid by Medicaid. Although a higher Medicaid consumption floor provides better protection against LTC risks to individuals without much wealth, the policy cost exceeds the benefit because it significantly increases the number of Medicaid residents at nursing homes. Less generous Medicaid decreases the number of Medicaid residents at nursing homes but hurts households without significant wealth. We conclude that adjusting Medicaid generosity alone cannot improve the overall welfare while providing better protection to poorer households.

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. To our knowledge, this is the first paper to incorporate both micro-founded demand for nursing home care and competitive nursing homes into an equilibrium model.

This paper extends the literature studying LTC policies that target the demand side by allowing for responses from the supply side of the market. De Nardi et al. (2016), Mommaerts (2018), and Achou (2023) study the role of Medicaid generosity for households; Ettner (1994) and Stabile et al. (2006) examine Medicaid home-care benefits. Though policies targeting the supply side of the market are not our main focus, we demonstrate that the effect of an increase in the Medicaid reimbursement rate—a policy typically examined in the supply-side literature (see, for example, Nyman, 1985, Gertler, 1989, Grabowski, 2001, and Hackmann, 2019)—in our model is in line with the findings from the literature.

To date, few models study equilibrium in 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 utility value for using in-home care, we explicitly model the trade-offs faced by heterogeneous households when choosing among the LTC options, where the values of the options are affected by the LTC policies. Second, in contrast 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 LTC policies affect the 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 choice between nursing home care and in-home care, where the latter is often supported by help from family members. Papers that examine this decision-making empirically include Mommaerts (2016, 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 (2022) study the implication of this choice on the LTC insurance demand. Our work contributes to this literature by showing that nursing home use is U-shaped in wealth, a novel empirical finding. We then examine the implications of the substitutability between nursing home care and in-home care on the effects of LTC 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., 2020) and demand for public and private LTC insurance (e.g., Brown and Finkelstein, 2008; Ameriks et al., 2018; Braun et al., 2019). Not only does our model augment a standard life-cycle model of retirees with explicit modeling of LTC decisions, but also our model is the first to capture decisions both on the extensive margin (the type of care used) and on the intensive margin (the intensity of care). Moreover, our analysis incorporates equilibrium interactions between the demand and supply of LTC.

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 its parameterization. Section 6 examines the effects of LTC policies. Section 7 concludes.

2 Empirical Patterns of LTC Demand and Supply

In this section, we examine the empirical patterns of LTC demand and supply. We examine both the extensive margin—use of nursing home versus in-home care—as well as the intensive margin—the *intensity* of care measured in the hours of care.

2.1 LTC Demand Patterns

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 use pooled data from waves 2004-2014, where we can find consistent questions on the number of care hours respondents receive when they need help with the activities of daily living (ADLs). We use the respondents in their 80s.[8]

We define the health status of individuals based on how many ADLs they need help with. We classify those who need help with at least three out of five ADLs—eating, bathing, dressing, walking across a room, and getting in or out of bed—as "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 of care hours from all, paid and unpaid, care providers 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 are 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 setup. Their setup 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.

Conditional on own health, the availability of family support also affects individuals' care choices. We classify those with either a living spouse who does not need help with ADLs or a child within 10 miles as having family support.[9] Panel B of Table 1 tabulates the LTC demand patterns by family status, conditional on ADLH. The care type used strongly depends on the availability of family support: While individ-

[8] Needing LTC is less prevalent below age 80; the sample is too small above age 90.

[9] We found that having a child but not within 10 miles does not affect the LTC usage.

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 are considered to have family support.

uals with family support predominantly choose 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 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 using nursing home care conditional on income and wealth quartiles as well as family support under ADLH. The share of nursing home care has a U-shape over income and wealth.[10] 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: Percent using nursing home care by wealth, income, and family support

	Wealth quartiles				Income quartiles			
Family structure	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Without family support	65	34	23	45	53	50	48	52
With family support	33	23	18	19	26	28	26	22

Note: Usage is tabulated conditional on ADLH. N=314 for those without family support; N=1,409 for those with family support. See notes for Table 1.

In the HRS data, the share of Medicaid enrollees among the individuals under ADLH is 27%. Taking into account that Medicaid program participation is under-reported in the HRS by 23% (De Nardi et al., 2016), we estimate the Medicaid rate

[10]The results are almost the same when we use the wealth from the previous wave to determine wealth quartiles to address the endogeneity of wealth to LTC use.

to be 35%. 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%.

The model we develop aims to capture the key patterns presented here. Higher use of in-home care with family support means that family support reduces the effective cost of using in-home care, 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 nursing home use over financial resources will be generated as an outcome of this trade-off.

2.2 Nursing Home Market Evidence

On the supply side of the LTC market, we focus on nursing homes. To obtain basic facts regarding local competition 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— a market fairly representative of the U.S. nursing home market (Hackmann, 2019).[11]

Hackmann (2019) reports that 90 percent of nursing home entrants travel less than 23 kilometers (approximately 15 miles) to find a nursing home. Therefore, we define a local nursing home market to cover 700 square miles (the size of a circle with a radius of 15 miles). According to the Nursing Home Reports data, there are 11 nursing homes per local market, and each nursing home has about 130 beds. Using Census data, we also find that there are 24,000 people who are 70 years or older per nursing home market.

The average out-of-pocket cost 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 for those who demand intensive LTC but do not have family support, as they also need to outsource basic home production. The institutional setup and standardization of

[11] 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.

[12] Nursing Home Reports; the cost is in 2017 dollars.

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

care allow a nursing home to provide care at a lower unit cost.

Most of nursing home revenues come from Medicaid and private payers. Hackmann (2019) documents that the Medicaid reimbursement rate is about $76,500, which is 10 percent lower than the out-of-pocket price, and the average fixed cost of operating a nursing home is about $1.3 million per year.

3 A Static Model of an LTC Market

To lay out the channels of the public LTC policy effects and establish the intuition for the full-fledged quantitative model, we start with a simple static model of the nursing home market, featuring optimizing consumers and a single producer. First, we derive the demand for nursing home beds by private payers and Medicaid enrollees. Second, we describe the nursing home optimization over the price and intensity of care given the demand. Finally, we discuss how public LTC policies affect market equilibrium.

On the demand side, our novel contribution is to explicitly capture LTC decisions on both the extensive margin (the type of care used) and the intensive margin (the care intensity). Consider a community of individuals who need LTC and have two options: in-home care or a nursing home. The two types of care differ in flexibility and prices: While the intensity of care received at home is decided by an individual, a nursing home provides a uniform intensity to all residents. The unit price of in-home care, ρ, differs between those who do not have a family member to help with LTC (S) and those who do (F): $\rho_F < \rho_S$. Moreover, individuals are heterogeneous in wealth, ω. Let the distribution of individuals be continuous over the support $\omega \in [\underline{\omega}, \bar{\omega}]$ $(\underline{\omega} > 0)$, with a cdf $\Phi_i(\omega)$, a continuous positive pdf $\phi_i(\omega)$, and share of individuals ψ_i, $i \in \{S, F\}$.

3.1 The Demand Side: Household Problem

Individual preferences are defined over consumption of non-care goods c and intensity of care q^k delivered either as in-home care ($k = \mathcal{H}$) or in a nursing home ($k = \aleph$): $U^k = u(q^k) + v(c)$, where $u(.)$ and $v(.)$ are increasing, continuous, twice continuously differentiable, concave, and satisfy the Inada conditions. The cost of in-home care is linear in care hours, with the price ρ per hour. The nursing home care costs P and comes with the fixed intensity Q. Individual resources—wealth (ω) and government transfers T^k available for care type k—are allocated between expenditures on care and non-care goods: $\omega + T^{\mathcal{H}} = c + \rho q$ for in-home care and $\omega + T^{\aleph} = c + P$ for nursing home care.

We first derive private demand for care in the absence of public assistance: $T^k = 0$ for all k. Nursing home care is preferred if the utility attained in a nursing home exceeds the utility obtained with in-home care:

$$U^{\aleph}(\omega, P, Q) = u(Q) + v(\omega - P) \geq U^{\mathcal{H}}(\omega, \rho) \equiv \max_q u(q) + v(\omega - \rho q), \qquad (1)$$

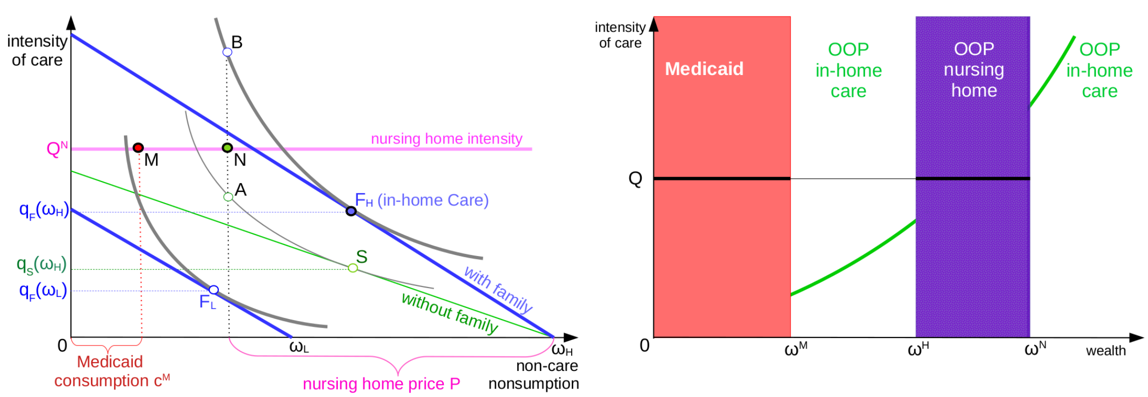
where the optimal choice of in-home care intensity $q^\star$ equalizes the marginal rate of substitution between the care and non-care consumption and the marginal cost of care: $\frac{u'(q^\star)}{v'(\omega - \rho q^\star)} = \rho$.

Recall that $\rho_F < \rho_S$. In Figure 1a, optimal in-home care allocations of F and S, both with wealth ω_H, are indicated by points F_H and S. The indifference curves passing through those points correspond to the individual participation constraints for nursing home care (1). 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 intensity at least as high as point A for the single individual with wealth ω_H, and at least as high as point B for the one with family, to be accepted at the wealth level ω_H. 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.

Figure 1: Demand for LTC

(a) LTC choice

(b) Allocation of care by wealth



Proposition 1. *As long as a unit of nursing home care is cheaper than a unit of in-home care ($\frac{P}{Q} < \rho$), there exists a wealth interval $(\omega^{\mathcal{H}}, \omega^{\aleph})$ such that for $\omega \in (\omega^{\mathcal{H}}, \omega^{\aleph})$ a nursing home is preferred over the in-home care. Moreover, the interval expands with the relative price of in-home care, $\rho / \frac{P}{Q}$.*

Now consider a Medicaid LTC policy that allows poor individuals to access nursing home care or an equivalent amount of home care services. An individual is eligible to have their care paid by Medicaid if the individual resources are insufficient to achieve a minimum consumption $c^{\mathcal{M}}$ under the nursing home care: $\omega \leq \tilde{\omega} = c^{\mathcal{M}} + P$. The Medicaid transfer is $T^{\mathcal{M}} = max\{0, c^{\mathcal{M}} + M - \omega\}$, where M is the Medicaid reimbursement rate to the nursing home. Let $\mathbf{T}$ be the vector of public LTC transfers: $\mathbf{T} = \{T^{\mathcal{H}}, T^{\aleph}, T^{\mathcal{M}}\}$. For individuals eligible for Medicaid, care choice is reduced to private in-home care ($k = \mathcal{H}$) versus Medicaid-financed care ($k = \mathcal{M}$):

$$\max\left\{U^{\mathcal{H}}(\omega, \rho|\mathbf{T}), U^{\mathcal{M}}(Q|\mathbf{T})\right\}. \tag{2}$$

Figure 1a illustrates how Medicaid makes an individual with wealth level ω_L, who has family support, nevertheless prefer Medicaid care (point M) to private in-home care (point F_L), under no public subsidy other than Medicaid ($T^{\mathcal{H}} = T^{\aleph}$=0).

Proposition 2. *For each* $(\rho, Q|\mathbf{T})$ *there exists a wealth level* $\omega^{\mathcal{M}} \in (\underline{\omega}, \tilde{\omega}]$ *such that for any* $\omega \in [\underline{\omega}, \omega^{\mathcal{M}})$ *Medicaid care is preferred to private care.* $\omega^{\mathcal{M}}$ *increases with Medicaid generosity* ($c^{\mathcal{M}}$)*, nursing home intensity* (Q)*, and in-home care price* (ρ)*.*

Notice that for Medicaid care recipients, given a relatively high level of nursing home care intensity (Q) and a relatively low level of non-care consumption ($c^{\mathcal{M}}$), the marginal rate of substitution, $\frac{u'(Q)}{v'(c^{\mathcal{M}})}$, is well below that under out-of-pocket in-home care, $\frac{u'(q^*)}{v'(\omega - \rho q^*)}$. Moreover, as long as the Medicaid reimbursement rate to the nursing home, M, is not too small compared to the out-of-pocket price P, the marginal rate of substitution faced by Medicaid recipients is also likely to be much smaller than the marginal cost of care faced by Medicaid: $\frac{u'(Q)}{v'(c^{\mathcal{M}})} < \frac{M}{Q}$. This implies a potential allocative inefficiency under Medicaid: Although Medicaid is effective in protecting poor households, households who do not take into account the marginal cost of care end up using a much higher level of care compared to those with wealth marginally above $\omega^{\mathcal{M}}$. Pashchenko and Porapakkarm (2019) and Arapakis et al. (2022) make similar arguments for inefficiency under Medicaid.

Proposition 3: *For given* $(\rho, P, Q|\mathbf{T})$*, the demand for care is segmented into at most four continuous wealth regions corresponding to care choices as follows (in the increasing wealth order): Medicaid care,* $[\underline{\omega}, \omega^{\mathcal{M}}]$*, private in-home care* $(\omega^{\mathcal{M}}, \omega^{\mathcal{H}})$*, private nursing home* $[\omega^{\mathcal{H}}, \omega^{\aleph}]$*, and private in-home care* $(\omega^{\aleph}, \bar{\omega}]$*. The wealth cutoffs respond to changes in the cost and intensity of care as follows:*

1. *Higher nursing home intensity* (Q) *or in-home care price* (ρ) *expands both Medicaid and private nursing home care regions:* $\frac{\partial \omega^{\mathcal{M}}}{\partial x} \geq 0, \frac{\partial \omega^{\mathcal{H}}}{\partial x} \leq 0, \frac{\partial \omega^{\aleph}}{\partial x} \geq 0, \quad x \in \{Q, \rho\}$.

2. *Higher* P *reduces the private nursing home region:* $\frac{\partial \omega^{\mathcal{M}}}{\partial P} = 0, \frac{\partial \omega^{\mathcal{H}}}{\partial P} \geq 0, \frac{\partial \omega^{\aleph}}{\partial P} \leq 0$.

Figure 1b illustrates market segmentation established in Proposition 3. The demand for nursing home care consists of private payers' demand and Medicaid enrollees' demand (colored areas). Private payers are individuals whose wealth is significant (but not too large), for whom the intensity of the nursing home care is relatively close to what they would have chosen were the nursing home care flexible. Households in the bottom wealth quartile enter a nursing home as Medicaid residents. This demonstrates how our model of LTC choice can produce the U-shape of nursing home use documented in Section 2.1.[14]

Private (n) and Medicaid (m) demands for nursing home beds can be stated as

$$n(P, Q|\mathbf{T}) = \sum_{i \in \{S,F\}} \psi_i n_i(\rho_i, P, Q|\mathbf{T}) = \sum_{i \in \{S,F\}} \psi_i \left[\Phi_i(\omega_i^{\aleph}) - \Phi_i(\omega_i^{\mathcal{H}})\right], \tag{3}$$

$$m(Q|\mathbf{T}) = \sum_{i \in \{S,F\}} \psi_i m_i(\rho_i, Q|\mathbf{T}) = \sum_{i \in \{S,F\}} \psi_i \Phi_i(\omega_i^{\mathcal{M}}). \tag{4}$$

3.2 The Supply Side: Nursing Home Problem

Given the demands derived above, a monopolistic nursing home chooses the price and intensity of care.[15] 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. The nursing home takes as given the reimbursement rate, $M < P$, set and paid by Medicaid. Providing care of intensity Q to each of the $N = n + m$ residents incurs cost $\mathcal{C}(N, Q)$, which has the following properties: The marginal cost of resident, $\mathcal{C}_N$, is increasing in the number of residents 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.[16]

The nursing home chooses price and intensity taking as given the private and Medicaid demand schedules, $n(P, Q|\mathbf{T})$ and $m(Q|\mathbf{T})$, so as to maximize its profits:

$$\max_{P,Q} \quad Mm(Q|\mathbf{T}) + Pn(P, Q|\mathbf{T}) - \mathcal{C}(n(P, Q|\mathbf{T}) + m(Q|\mathbf{T}), Q). \tag{5}$$

[14] In the quantitative model presented in the next section, the LTC choices are non-deterministic due to the preference shocks. The fraction of individuals entering a nursing home increases with the utility gap between nursing home care and in-home care options, creating the U-shape of nursing home use instead of intervals of deterministic choices.

[15] In the full-fledged quantitative model, we consider competition among local nursing homes.

[16] The 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).

The first-order conditions for price and intensity of nursing home care are

$$-(P-\mathcal{C}_N)\frac{\partial n}{\partial P} = n(P,Q|\mathbf{T}), \tag{6}$$

$$(M-\mathcal{C}_N)\frac{\partial m}{\partial Q} + (P-\mathcal{C}_N)\frac{\partial n}{\partial Q} = \mathcal{C}_Q. \tag{7}$$

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 resident and $(M-\mathcal{C}_N)$ is the marginal profit on a Medicaid resident, which we assume to be positive. Equation (6) 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 the nursing home in favor of relatively cheaper in-home care (the left-hand side). Equation (7) 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 a higher care intensity.

3.3 Policy Implications

In this section, we examine the equilibrium implications of LTC policies and government expenditure in particular. Expenditures on the Medicaid program are composed of transfers to the nursing home and to the qualifying households:

$$G^{\mathcal{M}} = (M + c^{\mathcal{M}})m(Q|\mathbf{T}) - \sum_{i\in\{S,F\}} \psi_i \int_{\underline{\omega}}^{\omega_i^{\mathcal{M}}(Q|\mathbf{T})} \omega d\Phi_i(\omega). \tag{8}$$

Suppose there exists a market equilibrium where the nursing home makes positive profits given Medicaid policy $(M, c^{\mathcal{M}})$. We now consider two policies targeting the demand for LTC: (i) subsidy to in-home care and (ii) more generous Medicaid.

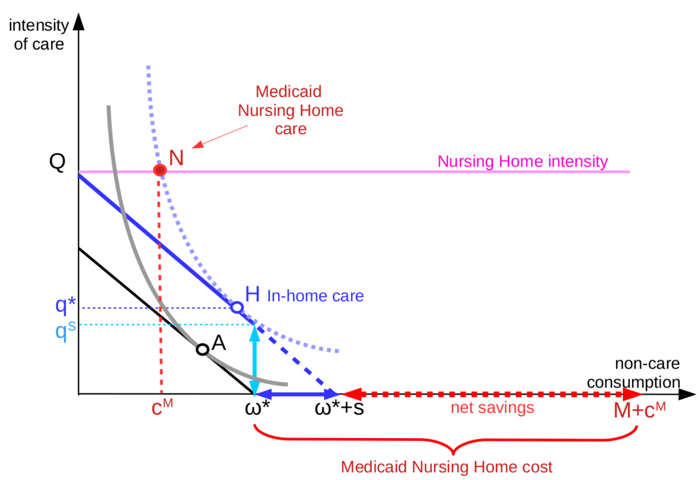
3.3.1 Subsidy to In-home Care

Consider a lump-sum subsidy, s, for out-of-pocket in-home care (or an equivalent provision of fixed hours of care at home) to individuals who do not have family help: $T^{\mathcal{H}} = s\mathbb{1}_{i=S}$ where $\mathbb{1}$ is the indicator function. The Medicaid rules remain the same. Let T_H be the vector of transfers under this policy.

Intuitively, the subsidy reduces the out-of-pocket cost of in-home care, making it relatively more attractive. As marginal individuals switch from nursing home care and Medicaid to out-of-pocket in-home care, nursing homes respond to the drop in demand by revising their intensity and pricing. We now discuss the direct and indirect effects of the policy in detail.

The direct effect Figure 2 illustrates how an in-home care subsidy can benefit both the consumer and the government. Consider a Medicaid enrollee with wealth ω^* who, in the absence of subsidy, strictly prefers nursing home care (point N) to in-home care (point A). Suppose a flat subsidy s to out-of-pocket in-home care (or an equivalent provision of q^s hours of care at home) makes the individual indifferent between staying at a nursing home paid by Medicaid or switching to subsidized out-of-pocket in-home care (point H): $U^{\mathcal{H}}(\omega^*, \rho|\mathbf{T}_H) = U^{\mathcal{H}}(\omega^* + s, \rho|\mathbf{T}) = U^{\mathcal{M}}(Q|\mathbf{T}_H)$. The cost of care for this marginal individual to the government is $M + c^{\mathcal{M}} - \omega^*$ under Medicaid while it is s under the out-of-pocket in-home care. Any Medicaid resident with wealth $\omega > \omega^*$ is strictly better off with the subsidized in-home care because $U^{\mathcal{H}}(\omega, \rho|\mathbf{T}_H) > U^{\mathcal{H}}(\omega^*, \rho|\mathbf{T}_H) = U^{\mathcal{M}}(Q|\mathbf{T}_H)$. As these individuals switch to subsidized in-home care, government expenditures change by $-\int_{\omega^*}^{\omega^{\mathcal{M}}(Q|\mathbf{T})}(M + c^{\mathcal{M}} - \omega - s)d\Psi(\omega)$. As long as the subsidy is smaller than the expenditures on a Medicaid nursing home resident, i.e., $M + c^{\mathcal{M}} - \omega - s < 0$, this move benefits both the consumers and the government.

Figure 2: Subsidy to in-home care: direct effect



Better social insurance at a lower public cost is achieved by removing the large wedge between the MRS between the care and non-care consumption and the cost of care for marginal Medicaid nursing home residents (see Section 3.1 and Figure 2). Better allocative efficiency is attained by inducing individuals to face the marginal cost of care and thus choose a consumption bundle that better aligns their preferences with the relative price.

The uniform nature of the subsidy implies that there are two more groups of individuals who benefit from this policy but at the full cost to the government: (i) individuals who use out-of-pocket in-home care regardless of the subsidy and (ii) individuals who switch from an out-of-pocket nursing home care to out-of-pocket in-home care. Total government spending under the in-home care subsidy is

$$G = G^{\mathcal{M}} + \psi_S s(1 - m_S(\rho_S, Q|\mathbf{T}_H) - n_S(\rho_S, P, Q|\mathbf{T}_H)). \tag{9}$$

Differentiating the government expenditure (9) with respect to s, we obtain the direct marginal impact of the policy on the government expenditure:

$$dG^{direct} = \psi_S \left[\underbrace{-\left(M + c^{\mathcal{M}} - \omega_S^{\mathcal{M}} - s\right)\phi_S(\omega_S^{\mathcal{M}})}_{Medicaid} + \underbrace{s\frac{\partial n_S}{\partial s}}_{OOP\ NH} + \underbrace{1 - m_S - n_S}_{OOP\ in-home} \right] ds. \tag{10}$$

Notice that the direct effect is limited to the targeted population—individuals without family. The first term captures savings on those who switch from Medicaid to out-of-pocket in-home care; the last two terms correspond to expenditures on those who switch from out-of-pocket nursing home care and those who would use out-of-pocket in-home care even without the subsidy. If Medicaid savings dominate the subsidy expenses, the direct effect reduces the government expenditure.

The equilibrium effect Faced with higher competition from in-home care, the nursing home has an incentive to reoptimize P and Q. As a result, the effects of the subsidy designed for individuals without family go beyond the targeted population. The fall in the number of private and Medicaid residents reduces both the marginal cost of a bed ($\mathcal{C}_N$) and the marginal cost of care intensity ($\mathcal{C}_Q$) in equation (7), both leading to an increase in intensity. The effect on price remains ambiguous.

The nursing home response introduces a feedback effect on government expenditure. As individuals relocate across the types of LTC due to changes in the nursing home price-intensity offer, government expenditure changes by

$$dG^{equil} = \left[\sum_{i \in \{S,F\}} \psi_i \left(M + c^{\mathcal{M}} - \omega_i^{\mathcal{M}} - s\mathbb{1}_{i=S}\right) \frac{\partial m_i}{\partial Q} - s\frac{\partial n_S}{\partial Q} \right] dQ - s\frac{\partial n_S}{\partial P} dP. \tag{11}$$

The first term captures the change due to a response in Q and the second term captures the change due to a response in P. When the nursing home increases Q facing the out-of-pocket in-home care subsidy, this offsets the policy effect to some degree, as it makes it more attractive to enter a nursing home as a Medicaid resident. For each individual that reverts to the Medicaid option, the government expenditure increases by $\left(M + c^{\mathcal{M}} - \omega^{\mathcal{M}} - s\right)$ for those without family and $\left(M + c^{\mathcal{M}} - \omega^{\mathcal{M}}\right)$ for those with family. The remaining terms capture the effects of individuals switching between in-home care and out-of-pocket nursing home care due to joint changes in the nursing home intensity and price. This analysis shows that if we miss the equilibrium effect, we may over- or underestimate the gain from a policy.

3.3.2 More Generous Medicaid

Next, consider an increase in the consumption floor for all Medicaid recipients, $c^{\mathcal{M}}$. This policy directly increases the welfare of the Medicaid recipients. As the Medicaid option becomes more attractive, individuals switch from private care to Medicaid-financed care.

The direct effect The direct effect of this policy on Medicaid expenditures comes through both intensive and extensive margins. On the intensive margin, expenditures on all initial Medicaid recipients increase as they enjoy higher consumption. On the extensive margin, Medicaid outlays increase due to the inflow of new Medicaid enrollees. Thus the direct change in government expenditure has two terms:

$$dG^{direct} = \left[\underbrace{m}_{intensive\ \ margin} + \underbrace{\sum_{i \in \{S,F\}} \psi_i \left(M + c^{\mathcal{M}} - \omega_i^{\mathcal{M}} \right) \phi(\omega_i^{\mathcal{M}}) \frac{\partial \omega_i^{\mathcal{M}}}{\partial c^{\mathcal{M}}}}_{extensive\ \ margin} \right] dc^{\mathcal{M}}. \tag{12}$$

Though the increased Medicaid generosity provides better protection to poor households, its direct impact significantly increases government expenditure.

The equilibrium effect The reaction of the nursing home to the increase in the demand for Medicaid beds is the opposite of its reaction to the fall in demand under the subsidy to in-home care. The inflow of Medicaid residents primarily increases the marginal costs of beds, $\mathcal{C}_N$, and hence reduces the profit margin on both types of beds (the left-hand-side of equation (7)). As a result, the nursing home has an incentive to reduce care intensity. The lower Q partially offsets the increase of Medicaid nursing home residents, thereby mitigating the increase in Medicaid expenditure:

$$dG^{equil} = \left[\sum_{i \in \{S,F\}} \psi_i \left(M + c^{\mathcal{M}} - \omega_i^{\mathcal{M}} \right) \phi(\omega_i^{\mathcal{M}}) \frac{\partial \omega_i^{\mathcal{M}}}{\partial Q} \right] dQ. \tag{13}$$

We conclude that equilibrium effects for both policies can mitigate the direct effects. To what extent these effects are quantitatively important and how these policies influence the overall welfare are the focus of the quantitative analysis presented below.

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 survival, health/LTC needs, and, for those with children, child proximity. In addition to the LTC choices, they make saving decisions and value bequests. On the supply side, we explicitly model local competition among nursing homes.

4.1 Households

Households 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, we assume that both spouses are the same age.

2. Wealth (W_t): The total value of wealth owned by the household.[17]

3. Health status ($\mathbf{h}_t = \{h_{m,t}, h_{f,t}\}$): *Good*, $Fair$, *Bad*:$ADLL$, and *Bad*:$ADLH$, depending on how much help with ADLs is needed. There is no need for LTC in the *Good* or $Fair$ state; however, it affects the health transition probabilities.[18] It is a vector, capturing the health of male ($h_{m,t}$) and female ($h_{f,t}$) separately.

4. Family status (F_t) keeps track of who is alive, child presence and availability, defined as living within a 10-mile radius.

5. Permanent income ($\mathbf{Y} = \{Y_m, Y_f\}$): Defined as retirement income from Social Security and defined-benefit pensions for each of the initial members of the household.

To simplify the notation, we drop the age subscripts and use a prime to denote the next period.

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

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

[18]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.

four states described above as well as *Death* as the absorbing state. The health transition matrix is a function of age, gender, marital status (single versus coupled), and permanent income ($\mathbf{Y}$) of households. Retirement income ($\{y_m^F, y_f^F\} = \mathbf{y}^F$) is collected only by alive members; it changes when a member is widowed and starts receiving survivor benefits, to the larger value in the couple's income vector.[19] Lastly, the family status (F) changes when one is widowed. If this household has a child but not nearby, consistently with the HRS data, we allow for a 50% chance that a child moves to within the 10-mile radius.

4.1.2 Preferences

Households' flow utility from care (q) and non-care (c) consumption is

$$U^{\mathbf{k}}(\mathbf{c}, \mathbf{q}; \mathbf{h}, F) \equiv \sum_{g=m,f} \mathbf{1}_g[\theta_g^h u(q_g^k; h_g) + \nu(c_g + \mathbf{I}^{k_g=\aleph}\Delta_{\aleph} + \mathbf{I}^{k_g=\aleph\mathcal{M}}\Delta_{\aleph\mathcal{M}}^{\mathbf{h},F})], \tag{14}$$

where $\mathbf{1_g} = 1$ if a household member of gender g is alive and is 0 otherwise. The relative importance of care consumption is governed by the utility weight, θ_g^h, which is zero when the health is *Good* or *Fair*, 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 $\mathbf{k}$ refers to the type of care chosen (discussed below). Note that the health state affects not only θ_g^h but also u, to allow for the possibility that the subsistence level of LTC may be different for $ADLL$ vs. $ADLH$. 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 provided by a nursing home: $\Delta_{\aleph}$ for a private resident or $\Delta_{\aleph\mathcal{M}}^{\mathbf{h},F}$ for a Medicaid resident, where the latter is a function of health and family status (discussed below).

4.1.3 LTC Options

When a member's health is *Bad*, households can choose to either enter a nursing home or use in-home care.[20] 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 $j \in \aleph$,

[19] 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.

[20] 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).

individual care status $k = j$ means entering nursing home j as a private payer, and $k = j\mathcal{M}$ means entering it as a Medicaid resident. Similarly, $k = \mathcal{H}$ means using in-home care paid out of pocket, and $k = \mathcal{HM}$ means using in-home care paid by Medicaid.

Nursing home j provides Q_j hours of care for both out-of-pocket ($k = j$) and Medicaid ($k = j\mathcal{M}$) residents. An out-of-pocket nursing home stay and a Medicaid nursing home stay differ in their costs and the consumption value provided by a nursing home. The out-of-pocket cost is P_j per year. Staying in a nursing home as a private patient also comes with a fixed consumption value, $\Delta_{\aleph}$, capturing basic amenities and assumed to be the same across nursing homes.[21] Medicaid residents do not pay for the nursing home stay but face restrictions on the amounts of wealth and income they are allowed to keep (specified later in the section). The consumption values of Medicaid nursing home stay, $\{\Delta_{\aleph\mathcal{M}}^{\mathbf{h},F_t}\}$, are allowed to differ from $\Delta_{\aleph}$ and are intended to capture factors affecting selection into Medicaid nursing home residency which are outside of our model.[22] We allow these values to differ by marital status F and by an LTC need.

The main benefit of out-of-pocket in-home care ($k = \mathcal{H}$) is the flexibility in choosing both the care hours and non-care consumption 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. The unit price of care depends on the family structure and the health status. That is, the effective cost of in-home care is lower for individuals with a healthy spouse or a child living nearby. Those who do not have family help for LTC also need to pay a fixed amount Ξ for housekeeping services 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, $Q_{\mathcal{HM}}^h$, which is allowed to be different between $h = ADLH$ and $h = ADLL$. Because the out-of-pocket price is zero, individuals in the model always use the maximum allowed number of hours. Households using

[21] Although we do not allow nursing homes to compete on the value of basic amenities, residents can top up their consumption in nursing homes out of pocket, which captures additional amenities they can purchase from a nursing home. In fact, private residents prefer this flexibility.

[22] These include the possibility of nursing homes providing fewer amenities to public residents, potential aversion to being in a nursing home as a Medicaid patient (Ameriks et al., 2011), and vagueness around homestead exemption and enforcement of estate recovery programs, as well as households' perceptions about these programs, as discussed in Achou (2023). De Nardi et al. (2021) also use a similar strategy by incorporating non-monetary factors such as stigma in their estimation of the "effective consumption floor."

this option face the same regulation regarding income and wealth to be kept as in the Medicaid nursing home option. In addition, the government guarantees a certain level of consumption floor, the value of which depends on having a "healthy spouse" (defined as a spouse without an LTC need).[23]

4.1.4 Transfers

Transfers in our model ensure that non-care consumption does not fall below certain levels guaranteed by government programs. Moreover, households with LTC needs are subject to Medicaid regulations on the amount of income and wealth Medicaid enrollees can keep.[24] 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 possible cases.

- Households that do not receive care paid by Medicaid receive a transfer when their own financial resources cannot cover the minimum non-care consumption Δ_W:
$$T = max\{0, \sum_{g=m,f} \mathbf{1}_g \left[\Delta_W - y_g^F\right] - W\}. \tag{15}$$
- 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 consumption transfer which guarantees the minimum non-care consumption $\Delta_W^{\mathcal{HM}1}$:
$$T = \sum_{g=m,f} \mathbf{1}_g \left[\Delta_W^{\mathcal{HM}1} \mathbf{I}^{k_g=\mathcal{HM}} - y_g^F\right] - W. \tag{16}$$
- Coupled households such that one member ($g = i$) is a Medicaid LTC enrollee and the other member ($g = j$) does not require LTC 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 set to prevent the impoverishment of the healthy spouse ($\underline{Y}$). For wealth, the household can keep 50% of wealth, to a maximum value of $\bar{W}$. The Medicaid LTC enrollee

[23] In parallel to the Medicaid nursing home, this consumption floor should be considered as an "effective" one, capturing not only the monetary value but also other factors affecting the selection into the Medicaid in-home care option not captured in our model.

[24] 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.

using in-home care receives a consumption transfer $\Delta_W^{\mathcal{HM}2}$:[25]

$$T = \Delta_W^{\mathcal{HM}2}\mathbf{I}_i^{k_i=\mathcal{HM}} - W - \sum_{g=m,f} \mathbf{1}_g y_g^F + \max\{y_j^F, \underline{Y}\} + \min\{0.5W, \bar{W}\}. \quad (17)$$

4.1.5 Budget Constraint

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

$$W' = (1+r)\left(W + \sum_{g=m,f} \mathbf{1}_g \left[y_g^F - c_g - LTC_g^k(q_g, \mathbf{h}, F)\right] + T\right), \quad (18)$$

where r is the risk-free rate of return. 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 the 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 $\mathbf{X} \equiv \{t, W, \mathbf{h}, F, \mathbf{y}\}$ be the household state, 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 $k = 0$ for households without LTC needs, is determined by solving

$$V^{\mathbf{k}}(\mathbf{X}; \mathbf{P}, \mathbf{Q}) = \max_{\mathbf{c},\mathbf{q},W'} \{U^{\mathbf{k}}(\mathbf{c}, \mathbf{q}; \mathbf{h}, F) + \beta\mathbf{E}\left[\eta_{\mathbf{X}} V(\mathbf{X}'; \mathbf{P}, \mathbf{Q}) + (1-\eta_{\mathbf{X}}))b(W')\right]\}, \quad (19)$$

where $\mathbf{X}' = \{t+1, W', \mathbf{h}', F', \mathbf{y}'\}$, and subject to the budget constraint (equation (18)), the transfer rules (equations (15)–(17)), the stochastic transitions of health and associated transitions of retirement income and family status explained in Section 4.1.1. β is the time discount factor, $\eta_{\mathbf{X}}$ is the probability of survival, and b is the bequest utility function. $V(.)$, the continuation value of the household, is determined

[25] Note that we do not explicitly model home equity that households are allowed to keep when there is a non-Medicaid-enrollee spouse who lives in the house, as we do not separately model housing and financial wealth. The home equity of households where one member is a Medicaid LTC enrollee is typically small, with the median of around \$60K, in the HRS. The impact of the special treatment of housing wealth under Medicaid regulations on selection into Medicaid is subsumed in the consumption values of Medicaid nursing home stays ($\Delta_{\aleph\mathcal{M}}^{\mathbf{h},F}$) and the consumption transfers to Medicaid enrollees using in-home care ($\Delta_W^{\mathcal{HM}1}$ and $\Delta_W^{\mathcal{HM}2}$).

by the choice of care type k as follows:

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

where ξ^k is a preference shock drawn for each care option available, *iid* across care options, nursing homes, time, and households, and scaled by $\theta_g^h \sigma_{\xi}$.[26] Assuming the shocks are drawn from a standard extreme value type I distribution, the probability of choosing care option $\mathbf{k} \in K$ is given by:

$$\pi^{\mathbf{k}}(\mathbf{X};\mathbf{P},\mathbf{Q}) = \frac{\exp\left(V^{\mathbf{k}}(\mathbf{X};\mathbf{P},\mathbf{Q})/(\theta_g^h\sigma_{\xi})\right)}{\sum\limits_{\mathbf{k}\in K}\exp\left(V^{\mathbf{k}}(\mathbf{X};\mathbf{P},\mathbf{Q})/(\theta_g^h\sigma_{\xi})\right)}. \tag{20}$$

4.1.7 Demand for Nursing Home Care

Let $\Psi(\mathbf{X})$ denote the distribution of households over the state space $\mathcal{X} \equiv \{\{1,\ldots,T\}\times R_+ \times \{Death, Good, Fair, ADLL, ADLH\} \times \{Death, Good, Fair, ADLL, ADLH\} \times \{No\ Child, Child\ nearby, Child\ not\ nearby\} \times R_+^2\}$. Aggregated across individuals, the probabilities of selecting into care option k (equation (20)) give rise to the private and Medicaid demand schedules for nursing home j:

$$n_j(P_j, Q_j|\mathbf{P}_{-j},\mathbf{Q}_{-j}) = \int\limits_{\mathbf{X}\in\mathcal{X}} \sum_{g=m,f} \mathbf{1}_g \pi_g^j(\mathbf{X};\mathbf{P},\mathbf{Q})d\Psi(\mathbf{X}), \tag{21}$$

$$m_j(Q_j|\mathbf{Q}_{-j}) = \int\limits_{\mathbf{X}\in\mathcal{X}} \sum_{g=m,f} \mathbf{1}_g \pi_g^{j\mathcal{M}}(\mathbf{X};\mathbf{Q})d\Psi(\mathbf{X}), \tag{22}$$

where $\mathbf{P}_{-j}$ and $\mathbf{Q}_{-j}$ are the vectors of prices and care intensities set by nursing homes other than j. As in Section 3, given the Medicaid rules, demand from the Medicaid enrollees (22) depends on the care intensities, $\mathbf{Q}$, but not prices, $\mathbf{P}$. The private demand depends on both prices and intensities of care. Both demands are derived under the LTC transfer rules (implicit in our notation). 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 with identical cost structure. They observe the demand for nursing home care and compete in a local market by simulta-

[26] The preference shock effectively introduces heterogeneity in the goods produced by nursing homes, which is necessary for modeling the competition among nursing homes. In our model, the preference shocks account for other factors relevant to the choice but not explicitly modeled, such as distance from family and specific nursing home amenities.

neously choosing the price and intensity of care. Nursing home j maximizes profits, taking as given prices and care intensities of the other nursing homes on the market:

$$\max_{P_j, Q_j} n_j(P_j, Q_j|\mathbf{P}_{-j}, \mathbf{Q}_{-j})P_j + m_j(Q_j|\mathbf{Q}_{-j})M - \mathcal{C}(N_j, Q_j) - \chi, \tag{23}$$

where $N_j = n_j(P_j, Q_j|\mathbf{P}_{-j}, \mathbf{Q}_{-j}) + m_j(Q_j|\mathbf{Q}_{-j})$ is the total number of residents, χ is the fixed cost of operation, and M is the Medicaid reimbursement rate.[27] The variable cost function $\mathcal{C}(.)$ is an increasing function of both the number of patients and the intensity of care. The associated first-order conditions are similar to the ones derived in Section 3:

$$-(P_j - \mathcal{C}_N(N_j, Q_j))\frac{\partial n_j}{\partial P_j} = n_j(N_j, Q_j|\mathbf{P}_{-j}, \mathbf{Q}_{-j}), \tag{24}$$

$$(M - \mathcal{C}_N(N_j, Q_j))\frac{\partial m_j}{\partial Q_j} + (P_j - \mathcal{C}_N(N_j, Q_j))\frac{\partial n_j}{\partial Q_j} = \mathcal{C}_Q(N_j, Q_j). \tag{25}$$

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.

4.2.1 Nursing Home Market Equilibrium

Since nursing homes face symmetric demand schedules and identical cost structure, the solutions to their profit-maximization problems are also symmetric. Therefore, we can define a symmetric Nash equilibrium for the nursing home market.

Definition *Given the Medicaid reimbursement rate M and the residual household demands (21) and (22) 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 (23) 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 (23) 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 Parametrization

We parametrize the model in three steps. First, we set the values of parameters that 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 summarizes the parameters in the model and the assigned values.

5.1 Preferences

We use a standard CRRA utility function for non-care consumption: $\nu(c) = \frac{c^{1-\gamma_1}}{1-\gamma_1}$, where $\gamma_1 = 3$, a standard value in the literature. Utility from care consumption is $u(q;h) = \frac{(q-\kappa_h)^{1-\gamma_2}}{1-\gamma_2}$, where the subsistence level of care, $\kappa_h > 0$, governs the left tail of the distribution of care hours used (q). We set it to be 100 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 conditional on h. Note that with the utility multiplier, θ_h, in the overall flow utility function (equation (14)), our utility function essentially has the same functional form as in Ameriks et al. (2020). 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 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 $\gamma_2 = 1.127$.

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

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. (2020)
$\Delta_{\mathcal{N}}$	\$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	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	SSI
χ	\$1.3M	NH fixed cost of operation	Hackmann (2019)
$\underline{Y}, \bar{W}$	\$25K, \$120K	Medicaid eligibility parameters	PA Medicaid rules
B. Estimated from the data			
Π_H	See Appendix A	Health transition matrices	HRS data
$Q^h_{\mathcal{HM}}$	2,000 for $h = ADLH$ 1,500 for $h = ADLL$	Care hours under Medicaid in-home care	HRS data
J	11	Number of nursing homes	PA Department of Health
C. Determined using indirect inference			
γ_2	1.127	Risk aversion over care consumption	Mean/median for q in ADLH
θ_h, κ_h	0.00081, 100 for $h = ADLH$ 0.00019, 50 for $h = ADLL$	Care utility function parameters	Mean and 25-pctl of q
σ_ξ	0.15	S.d. of preference shocks	Share of care type choice explained by observables
$\Delta^{\mathbf{h},F}_{\aleph\mathcal{M}}$	\$10.48K for $h = ADLH$, no spouse in community \$10.25K for $h = ADLL$, no spouse in community \$0.5K if spouse in community	Consumption value of Medicaid stay at a NH	Share of Medicaid enrollees under NH
$\Delta^{\mathcal{HM}1}_W$, $\Delta^{\mathcal{HM}2}_W$	\$10.50K, \$1.0K	Consumption floor under Medicaid in-home care	Share of Medicaid enrollees under in-home care
ρ w/ family	\$21.0	In-home care hourly cost w/ family	Diff. in in-home care share between w/ and w/o family
ζ	0.261	Scale of NH cost function	Profit after the fixed cost
α, β	1.408, 0.532	Curvature over number of beds and care intensity in NH cost function	$P_j = \$85K$, $Q_j = 2,000$

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

numbers reported in Table 2 (see Section 5.5).[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. (2020), the bequest utility function is set to $b(W) = \theta_b \frac{(W-\kappa_b)^{1-\gamma}}{1-\gamma}$, 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. (2020), 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. Note that our stationary analysis does not allow for the population aging. The transition probabilities over the five health states ($Good$, $Fair$, $ADLL$, $ADLH$, and death) are estimated conditional on age, gender, marital status, and permanent income of the household, as in Jones et al. (2018). See Appendix A for details.

5.3 LTC Costs and Values

Nursing home care In the baseline model, there are 11 nursing homes competing in one local 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: $\mathcal{C}(N_j, Q_j) = \zeta N_j^{\alpha} Q_j^{\beta}$. It is governed by three parameters: the scale parameter ζ 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 ζ such that, at the equilibrium price (P_j =\$85K)

[28] To make sure that options which are equally valued net of the preference shock—between in-home care versus nursing home—are chosen with equal probabilities, 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.

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 $\zeta = 0.261$ generates such a level of profit (see Section 5.5 for more details). The values of α and β target the clearance of the FOCs (equations (24) and (25)) from the nursing home's maximization problem at the equilibrium price and intensity. The cost function with the inferred parameter values suggests that the nursing homes face decreasing returns to scale over the number of residents ($\alpha = 1.408 > 1$) and increasing returns to scale over intensity ($\beta = 0.532 < 1$). The former is consistent with the physical capacity constraint on the number of beds, and the latter reflects lower cost of staff due to concentration of care in a single location.[29] Hackmann (2019) reports that the non-health-related resident cost for a nursing home is about one-third of the health-related cost. This corresponds to the consumption value of an out-of-pocket nursing home stay $\Delta_{\mathcal{N}} = \$20K$—approximately a quarter of the out-of-pocket expense. The consumption value of a nursing home stay for a Medicaid resident, $\Delta^{\mathbf{h},F}_{\aleph\mathcal{M}}$, targets the fraction of Medicaid patients among nursing home residents conditional on family status. For individuals without a healthy spouse in the community, the estimated consumption values are \$10.48K for $h = ADLH$ and \$10.25K for $h = ADLL$. For individuals with a healthy spouse in the community, the model requires nearly a null value (\$0.5K per year) in order to generate a very limited selection into the Medicaid nursing home option among such individuals (see Section 5.5). All of these values are much lower than $\Delta_{\mathcal{N}}$, potentially reflecting stigma or differences in amenities provided to Medicaid patients.

In-home care The out-of-pocket in-home care expenses are composed of two parts for those without family support: per-unit price (ρ_S, where S stands for "no family support") and 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 the care provider and the types of care needed. We set ρ_S to be \$35 per hour (in 2017 dollars), which is in the middle of this range. 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 and 1,500 hours

[29] For example, attending to a patient does not require commuting between locations as is the case for in-home care.

per year. We set Ξ to be 1,000×\$20=\$20K per year. We allow the unit cost of in-home care to 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 60% of ρ_S to match the difference in the share using in-home care between those who do and do not have family support. Note that, for private patients without family with a demand for care of around 2,000 hours per year, entering a nursing home is a cost-effective option relative to 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, which is smaller than \$90K for 2,000 hours of in-home ($\$35 \times 2000 + \$20K$).

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 maximum amount of wealth those households can keep ($\bar{W}$) is \$120K in Pennsylvania.

Under Medicaid in-home care, the number of care hours, $Q^h_{\mathcal{HM}}$, is set based on the health status. For $h = ADLH$, it is set to the care hours provided by a nursing home, i.e., 2,000 hours per year. For $h = ADLL$, it is set to 1,500 hours per year, based on the average care hours for this health status in the HRS.

The non-care consumption floor, Δ_W, is set to \$10K per year, based on the Supplemental Security Income in 2017. The consumption floor for Medicaid in-home care recipients targets the share of Medicaid patients among the in-home care users conditional on family status (see Section 5.5). We estimate these to be \$10.5K for households with both members receiving LTC ($\Delta_W^{\mathcal{HM}1}$) and \$1.0K for the rest ($\Delta_W^{\mathcal{HM}2}$).

The Medicaid reimbursement rate (M), the amount that Medicaid pays to nursing homes per Medicaid patient, is set to 90% of the out-of-pocket price, or \$76.5K (Hackmann, 2019).

[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 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 averages (the target for θ_h), the 25th percentiles (the target for κ_h), and the mean-to-median ratios (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 23 percentage points more likely to use in-home care, close to the difference from the data (Panel B). This is generated from the model by having the effective cost of in-home care be much lower for those with family support (ρ_F) than for those without family support (ρ_S). Lastly, Panel C shows that the model does a good job in producing the Medicaid participation patterns across health and family status as well as the type of care used. This is achieved by the calibration of three values of the consumption value of Medicaid nursing home stay ($\Delta_{\aleph\mathcal{M}}^{\mathbf{h},F}$) and two values of non-care transfers under Medicaid in-home care ($\Delta_{W}^{\mathcal{HM}1}$ and $\Delta_{W}^{\mathcal{HM}2}$).

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 29%. This was the target for σ_ξ, and the model closely matches that moment (32%). Furthermore, Figure 3 shows that the share using nursing home care has a U-shape over financial resources, in particular over wealth. At first, it decreases with financial resources and then increases. Similar patterns are generated from the model (solid lines), though the variation in these moments over wealth and income quartiles is not targeted. The size of the slopes is also similar between the data and the model.

Table 4: Model fit for the targeted moments

A. Care hours distribution						
	Health status	25p	50p	Mean	Mean/Median	N (Data)
Data	ADLH	1,116	2,000	2,489	1.24	1,723
	ADLL	240	720	1,242	1.73	1,205
Model	ADLH	1,142	2,000	2,503	1.25	
	ADLL	249	692	1,217	1.76	
B. Share using in-home care (%, under ADLH)						
Conditions				**Data**	**Model**	N (Data)
Have family help				75	77	1,385
Do not have family help				49	54	304
C. Share of Medicaid patients (%)						
		Single	Couple	Nursing home	In-home care	
Data	ADLH	42	23	55	27	
	ADLL	29	11	45	19	
Model	ADLH	43	32	70	26	
	ADLL	25	10	45	17	

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. For the Medicaid participation rate in Panel C, the empirical moments are adjusted for under-reporting, assuming the under-reporting rate of 23% (De Nardi et al., 2016).

At the equilibrium price (P_j =\$85K) and intensity ($Q_j = 2,000$), each nursing home has about 105 patients, where three-quarters of those are Medicaid patients. The revenue for each nursing home is \$8.4M, the variable cost is \$5.6M, and, hence, the annual profit before the fixed cost is \$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, the present value of the profits net of the fixed cost of operation is arguably not large enough to make an entry of a new nursing home profitable. Hence, $J = 11$ nursing homes are supported as a market equilibrium.

5.6 Model Validation Exercises on the Supply Side

In this section, we assess model performance on the supply side by simulating two policies typically studied in the LTC supply-side literature: (i) a 10% increase in the Medicaid reimbursement rate paid to nursing homes and (ii) incentivized entry of a nursing home, as in Hackmann (2019). Though the entry cost deters an entry of a new nursing home under the baseline profit level, an entry may occur if the government covers this cost.

Note that the Medicaid reimbursement rate, M, directly enters the FOC with

Figure 3: Percent in a nursing home 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.

respect to the care intensity (equation (25)). A higher M makes it more profitable to have a Medicaid resident. Therefore, nursing homes have an incentive to increase the intensity of care to attract more Medicaid residents. Indeed, in the new equilibrium of our quantitative model, the care intensity increases by 9.7% (by 194 hours of care per year). How does this compare to the findings from the existing papers? Grabowski (2001) highlights that nursing home responses to this policy change depend on whether the certificate-of-need (CON), which limits the number of residents at nursing homes, is binding or not. In 1980s, in some states including New York and Wisconsin, the CON was more likely to be a binding constraint. Papers using data from these states in that time period find that nursing homes reduce care intensity facing a higher Medicaid reimbursement rate (e.g., Gertler, 1989). However, papers using more recent data find that nursing homes increase the intensity of care, either measured by the outcome (e.g., Grabowski, 2001) or the number of nursing staff (Hackmann, 2019). The effect generated by our model, which has no CON constraint, is in line with the findings from these recent papers. It is also similar in magnitude to that in Hackmann (2019), who finds that the number of nursing staff increases by 8.7% when the Medicaid reimbursement rate increases by 10%.

Now consider an incentivized entry of a new nursing home, identical to the incumbents. Facing more intense competition, nursing homes increase the care intensity by 71 hours per year (or 3.6%), with a limited change in the price (an increase of $300 per year, or 0.4%). These limited responses are broadly in line with the findings from a structural estimation analysis in Hackmann (2019). He finds that the care intensity response ranges from +0.1% to +0.9% and the price response ranges from −0.7% to +0.1% among the four rural counties used in his analysis. We thus conclude that our modeling of the supply side of the nursing home market is an adequate description of the world for the questions at hand.

6 Policy Analysis

In this section, we use our quantitative model to investigate the implications of LTC policies on the three players in the nursing home market: households, nursing homes, and the government. We study two sets of policies that target the demand side of the market. First, motivated by our theoretical investigation in Section 3, we consider subsidies to individuals using in-home care paid out of pocket.[32] Second, we examine changes in Medicaid generosity, typically studied by the LTC demand literature. We evaluate the effects on the allocation of care, private and public cost of care, and welfare. To highlight the role of the nursing home market equilibrium, we limit our results to steady-state comparisons.

6.1 Subsidies for In-home Care

Motivated by our theoretical conjecture in Section 3, we examine policies that provide subsidies for using in-home care paid out of pocket. Recall that this type of care is particularly expensive for individuals without family support due to (i) the fixed cost of outsourcing home production and (ii) a higher marginal cost. Not surprisingly, these individuals are much more likely to be Medicaid recipients (see Section 5.5), consuming amounts of care that largely exceed the levels typically demanded by out-of-pocket in-home care recipients with family. We start with a uniform lump-sum

[32]In-home care subsidy has gained attention after COVID-19 outbreaks at nursing homes during the pandemic. See, for example, Achou et al. (2022).

subsidy to individuals without family support and then explore alternative formulations: a phased-out scheme, which gradually reduces the subsidy for the more affluent, and a proportional subsidy reducing the marginal cost of care.

6.1.1 Uniform Lump-sum Subsidy

Consider a policy that provides \$10K per year for all individuals without family support who use in-home care and pay for it out of pocket. The subsidy corresponds to half of the fixed cost of care, Ξ, faced by these individuals.

Figure 4a illustrates responses on the extensive and intensive margins in the allocation of care across the wealth distribution for individuals without family support, using the simple model setup from Section 3. The subsidy makes out-of-pocket in-home care more affordable, expanding the pool of individuals choosing this option (white arrows). The policy also affects the intensive margin: Those using the in-home care option enjoy a higher level of care than before with the subsidy (dashed curve). Panel A of Table 5 reports changes in the demand among the individuals without family help.[33] In the absence of nursing home responses, the fraction of individuals without family that use in-home care out of pocket increases by 14 percentage points, from 31 percent in the baseline. As predicted in Section 3, those who switch from the other options to the out-of-pocket in-home care in general use fewer care hours. As a result, individuals without family consume 130 hours per year less than in the baseline. Over the wealth quartiles, the increase in the out-of-pocket in-home care participation is evenly spread, though for the bottom wealth quartiles, this is due to the flows out of Medicaid, while for the top wealth quartiles, this is due to the flows out of private nursing homes (see Appendix Table B1). As a result, if nursing homes do not respond, they end up with fewer private and Medicaid residents (Table 5, Panel B). The decline is larger for private residents (5.8 residents per facility or 14%) than for Medicaid residents (3.4 residents per facility or 5%).

How do nursing homes respond to the drop in demand? The last two columns of Panel B of Table 5 show that nursing homes compete with a better in-home care option by increasing the care intensity by 133 hours per year (6.7%). That is, they use a tool that is effective in increasing demand by both Medicaid and private payers. At the same time, nursing homes increase the price by \$4.9K (5.8%) to cover the higher costs associated with higher care intensity. The black arrows in Figure 4a

[33] See Appendix Table B1 for the changes among those with family help as well as by wealth group.

Figure 4: Uniform in-home care subsidy on LTC demand

(a) On allocation of care (b) Net flows between care types

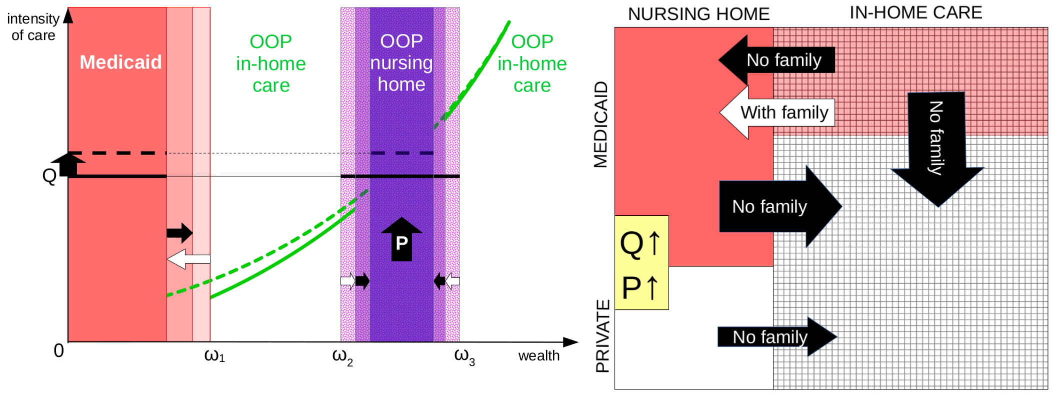


Table 5: In-home care subsidy: effects on LTC allocation and nursing homes

	Baseline	No NH response		NH response	
A. LTC allocation (without family)		Δ	$\Delta\%$	Δ	$\Delta\%$
Private in-home care (%)	31.5	+13.6	+43.2	+14.5	+46.0
Private nursing home (%)	21.8	−5.3	−24.3	−6.3	−28.9
Medicaid in-home care (%)	22.9	−4.1	−17.9	−5.7	−24.9
Medicaid nursing home (%)	23.8	−4.2	−17.6	−2.5	−10.5
Mean care intensity (hours per year)	2,229	−130	−5.8	−102	−4.6
B. Nursing homes (per facility)					
NH care intensity (Q, hours per year)	2,000	0	0	+133	+6.7
NH price (P, \$K)	85.0	0	0	+4.9	+5.8
Marginal cost (\$K)	69.8	−2.6	−3.7	+0.9	+1.3
Private residents	40.4	−5.8	−14.4	−7.9	−19.6
Medicaid residents	64.3	−3.4	−5.3	+2.7	+4.2
NH private revenue (\$M)	3.44	−0.50	−14.5	−0.52	−15.1
NH Medicaid revenue (\$M)	4.92	−0.26	−5.3	+0.21	+4.3
NH Profits (\$M)	1.87	−0.13	−7.0	−0.12	−6.4

illustrate that the higher care intensity somewhat offsets the effect of the in-home care subsidy on the margin between the Medicaid and out-of-pocket in-home care options by making the Medicaid nursing home option more attractive. However, the higher price further discourages private residents. The impact of the nursing home responses on the demand can also be seen in the last two columns of Table 5, Panel A.[34] In equilibrium, there is a gain of 2.7 Medicaid residents per nursing home or 4% (Table 5, Panel B, last two columns), mostly due to the flows from the Medicaid in-home care rather than the out-of-pocket in-home care. The higher care intensity

[34] See Panel B of Table B1 for more details.

increases the marginal cost by only 1.3% due to a smaller number of residents, and the profits fall by 6.4%.

Figure 4b summarizes the net flows between care types in the new equilibrium under the in-home care subsidy. In this figure, the red areas indicate Medicaid-financed care, while non-red areas indicate care paid out of pocket. The left (solid) column is nursing home care, while the right (patterned) column is in-home care. In equilibrium, the subsidy relieves Medicaid of financing a fraction of individuals without family, as reflected by the two thick black arrows from Medicaid care to private in-home care. The uniform nature of the policy produces an additional flow within the out-of-pocket care (bottom black arrow). All three inflows are mitigated by the higher intensity offered by nursing homes. Although the more intensive nursing home care creates flows of Medicaid recipients from in-home to nursing home care (top black and white arrows), they do not result in a higher Medicaid burden.

The last two columns in Table 6, Panel A, indicate that the consumer surplus increases by \$8.9M in the new equilibrium. All wealth quartiles gain from the subsidy to in-home care, though the ones at the bottom wealth quartile gain the least as they are less likely to pay for in-home care out of pocket even with the subsidy (Panel B). Total producer surplus decreases, but the magnitude of the change is small (\$1.3M). The increase in the consumer surplus comes with a much smaller increase in government program expenditures. Medicaid outlays[35] rise by \$4.0M, which is less than half of the increase in the consumer surplus. Though the government is now subsidizing \$10K for each household without family that uses in-home care out of pocket, increasing its total transfers by \$8.8M, by doing so it reduces the number of more costly Medicaid in-home care recipients, saving \$4.8M.

Taking into account nursing home responses is important for evaluating the welfare and fiscal effects of the policy. The first two columns in Table 6 show the changes in the surpluses and Medicaid savings under the assumption that nursing homes do not change their price and care intensity. When we do not take into account the equilibrium response, we underestimate the increase in Medicaid expenditures: \$1.3M as opposed to \$4.0M in the equilibrium. The increase in the nursing home care intensity partially undoes the cost-saving effect of this policy by making the Medicaid nursing home option more attractive. As a result, one would significantly

[35]We include the expenditure for the in-home care subsidy in the Medicaid expenditure for ease of comparison with other experiments, though the subsidy might be administered through other government programs. The table shows the Medicaid savings, so a negative change implies increased expenditures.

Table 6: In-home care subsidy: welfare evaluations

A. Aggregates	No NH response		NH response	
	Δlevel ($M)	Δ%	Δlevel ($M)	Δ%
Consumer surplus*	+8.6	NA	+8.9	NA
Producer surplus	−1.4	−7.0	−1.3	−6.4
Medicaid savings	−1.3	−1.7	−4.0	−5.1
Nursing home care	+2.9	+5.4	−2.3	−4.3
In-home care	+5.0	+10.9	+7.1	+15.5
Transfers	−9.2	−42.5	−8.8	−40.7
Total	+5.9	NA	+3.6	NA
B. Distribution				
Consumer surplus*	Δlevel (per household, $)			
Wealth: Q1	+677		+1,291	
Wealth: Q2	+3,379		+3,521	
Wealth: Q3	+6,616		+6,301	
Wealth: Q4	+6,469		+6,917	

Note: The table presents changes compared to the values in the baseline economy.
* 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.

overestimate the total welfare gain from this policy, by as much as $2.3M.

This policy experiment confirms our theoretical prediction from Section 3 that a well-designed in-home care subsidy can increase household welfare with a limited increase in Medicaid expenditures. The key behind this efficacy is to let households face the marginal cost of care while guaranteeing a certain level of care by providing subsidies, a principle shown to be successful in a different context by Pashchenko and Porapakkarm (2019) and emphasized by Arapakis et al. (2022).

6.1.2 Alternative Forms of In-home Care Subsidies

One might suspect that the uniform subsidy may be wasting resources on richer individuals who are unlikely to ever use Medicaid LTC. Therefore, we examine a "phased-out" version of the subsidy by stepping down the lump-sum amount at two thresholds of the household's cash-in-hand (the sum of wealth and income). Namely, households with cash-in-hand below $100K are eligible for $10K per year; between $100K and $160K, the subsidy is $5K per year; and there is no subsidy above $160K. The cutoffs are chosen based on the observation that in the baseline model, the Medicaid options are dominant below cash-in-hand of $100K, while they are rarely chosen above \$160K.[36]

Individuals without family help face not only a fixed cost but also a higher marginal cost of in-home care. To understand the role of the latter, we also consider a policy subsidizing each hour of in-home care paid out of pocket: Individuals receive \$3.5 per hour of in-home care used, reducing its marginal cost by 10%. We call this policy a "proportional" subsidy.

Table 7 reports welfare effects of the phased-out and proportional subsidies along with the uniform subsidy from Section 6.1.1.[37] We find that the phased-out subsidy is welfare-improving. It increases consumer surplus by \$2.6M while *reducing* the Medicaid expenditure by \$0.5M as fewer individuals choose both Medicaid nursing home and Medicaid in-home care. Although the net Medicaid savings are small, it still means that consumer benefits can be achieved with no additional tax burden.

Table 7: In-home care subsidies: welfare across policies

A. Aggregates	Δlevel (\$M)		
	Uniform	Phased-out	Proportional
Consumer surplus*	+8.9	+2.6	+4.5
Producer surplus	−1.3	−0.2	−0.7
Medicaid savings	−4.0	**+0.5**	−3.8
Nursing home care	−2.3	+0.3	−1.2
In-home care	+7.1	+3.4	+1.1
Transfers	−8.8	−3.2	−3.7
Total	+3.6	+2.9	−0.0
B. Distribution	Δlevel(per household, \$)		
Consumer surplus*	Uniform	Phased-out	Proportional
Wealth: Q1	+1,291	+804	+170
Wealth: Q2	+3,521	+1,741	+432
Wealth: Q3	+6,301	+1,940	+1,200
Wealth: Q4	+6,917	+845	+7,352

Note: The table presents changes compared to the values in the baseline economy.
* The consumer surplus is calculated as Table 6.

The total welfare gain is smaller under the phased-out subsidy than that under the uniform subsidy (\$2.9M versus \$3.6M). This is largely due to a big drop in the consumer surplus across the entire wealth distribution. This happens because the top half of the wealth distribution misses out on the insurance value of the subsidy, and the bottom half misses out on the intensity of nursing home care, which increases

[36] All other subsidy rules remain the same: It is available only to individuals without family for out-of-pocket in-home care.

[37] Detailed effects are reported in Appendix B.2.

much less under the phased-out subsidy. In fact, in the absence of nursing home reactions, the impact of the two policies on the bottom wealth quartile is almost the same. These comparisons once again illustrate the importance of taking into account nursing home reactions in understanding the welfare and distributional effects of various forms of in-home care subsidies.

In contrast to the lump-sub subsidies, the proportional in-home care subsidy is not welfare-improving. The sum of the increase in the consumer and producer surpluses (\$3.8M = \$4.5M - \$0.7M) is the same as the increase in the Medicaid expenditure (\$3.8M). Compared to the uniform lump-sum subsidy, the increase in the consumer surplus is about half, while the increase in Medicaid expenditures is similar. The regressivity of the proportional subsidy, shown in the distribution of the consumer surplus across wealth groups in Panel B, makes it an expensive and ineffective policy. The marginal individuals choosing between Medicaid and out-of-pocket in-home care would receive a small subsidy for their low levels of out-of-pocket in-home care. On the other hand, more affluent individuals will consume a large number of care hours, thus benefiting much more from this policy.

6.2 Changes in Medicaid Generosity

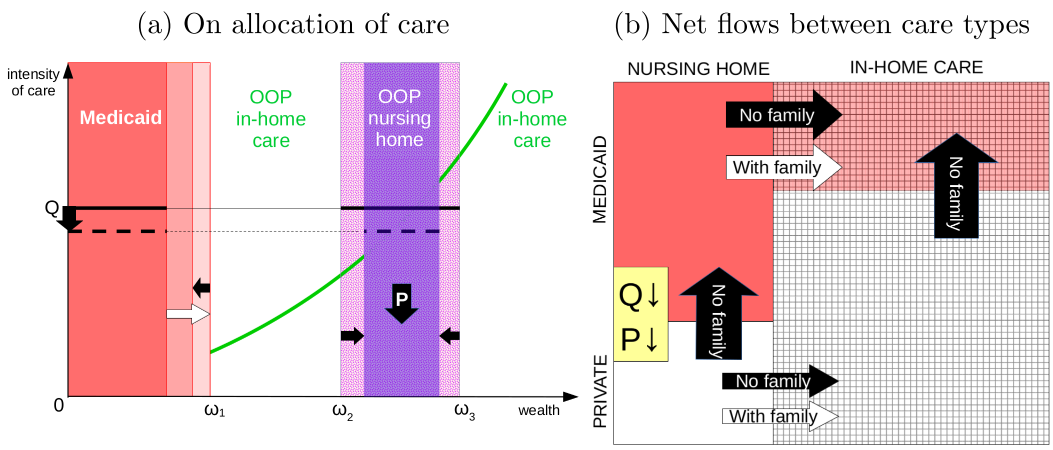
The generosity of Medicaid in our model is parameterized by the minimum consumption guaranteed to the recipients conditional on their family and care status: $\Delta_{\aleph\mathcal{M}}^{\mathbf{h},F}$ for nursing home residents; $\Delta_{W}^{\mathcal{HM}1}$ and $\Delta_{W}^{\mathcal{HM}2}$ for in-home care recipients. We consider a 20% proportional increase in all consumption floors.[38]

Figure 5a illustrates this impact based on the static model from Section 3. The white arrow indicates the direct impact on demand: More households use the Medicaid option as it becomes more attractive. The fraction of Medicaid enrollees increases by about 8 percentage points for the bottom two wealth quartiles, all of them switching from the out-of-pocket in-home care option (panel A of Appendix Table B9). As a result, the average care hours increase by more than 100 hours per year for those two wealth quartiles. As about half of the switchers choose nursing home care, the number of Medicaid residents increases by 27% (Table 8, second and third columns), though the extra profits are small.

A larger number of Medicaid residents increases the marginal cost, which in turn reduces the profit margin on both types of residents. This reduces the incentive to

[38]We also simulate a 10% decline in all consumption floors. The results, reported in Appendix Table B10, are the opposite of the more generous Medicaid case and are of a similar magnitude.

Figure 5: More generous Medicaid on LTC demand



maintain a high care intensity (equation (7)): In equilibrium, it falls by 135 hours per year or 6.8% (Table 8, the last two columns). The price change is also negative but limited ($0.9K or 1.0%) as its two key channels work in opposite directions: a larger number of residents drives the marginal cost up while lower care intensity reduces it.

Table 8: More generous Medicaid: effects on nursing homes

		No NH response		NH response	
		Δ	Δ%	Δ	Δ%
NH care intensity (Q, hours per year)	2,000	0	0	−135	−6.8
NH price (P, \$K)	85.0	0	0	−0.9	−1.0
Marginal cost (\$K)	69.8	+4.7	+6.7	−0.6	−0.9
Private residents	40.4	+0.6	+1.5	−1.9	−4.7
Medicaid residents	64.3	+17.6	+27.4	+9.5	+14.8
NH private revenue (\$M)	3.44	+0.05	+1.5	−0.21	−6.1
NH Medicaid revenue (\$M)	4.92	+1.34	+27.4	+0.72	+14.6
NH Profits (\$M)	1.87	+0.08	+4.3	+0.20	+10.7

These nursing home reactions, in turn, create additional changes in LTC allocation, as illustrated by black arrows in Figure 5a. The lower nursing home care intensity somewhat offsets the increase in the demand for the Medicaid nursing home option. On the other hand, the nursing home reactions reduce the private demand for nursing homes, as the decrease in the price is not large enough to compensate for the lower care intensity. Panel B of Appendix Table B9 has details on demand changes in the equilibrium.

Figure 5b summarizes the net flows between the four care types in the new equilibrium. The more attractive Medicaid options induce flows from private to Medicaid regions for both nursing home and in-home care, particularly among those without family help (vertical arrows). The horizontal flows from nursing home to in-home care for individuals with and without family occur in response to the lower intensity of nursing home care. In equilibrium, Medicaid residents increase by 9.5 per facility or 14.8%, while private residents decline by 1.9 or 4.7% (Table 8, the last two columns). As a result, each nursing home ends up with about 8 more residents and a higher share of Medicaid residents (66% vs. 61%).

Increasing Medicaid generosity is a costly policy to implement: Medicaid expenditure increases by $12.9M (Table 9, Panel A, the last two columns). While consumers get the lion's share of the gains from this policy, $11.7M, producers benefit too, by $2.2M, generating a small, $0.9M, increase in the overall welfare. However, the consumer surpluses are not equally distributed across the households (Panel B). The bottom two wealth quartiles gain the most, as Medicaid is a more likely option for these households. At the top wealth quartile, individuals experience a loss due to the lower intensity of nursing home care.

Table 9: More generous Medicaid: welfare evaluations

A. Aggregates	No NH response		NH response	
	Δlevel ($M)	Δ%	Δlevel ($M)	Δ%
Consumer surplus*	+15.3	NA	+11.7	NA
Producer surplus	+1.0	+6.1	+2.2	+10.7
Medicaid savings	−16.2	−20.7	−12.9	−16.5
Nursing home care	−14.8	−27.4	−8.0	−14.8
In-home care	−3.2	−7.0	−6.2	−13.5
Transfers	+1.8	+8.3	+1.3	+6.0
Total	+0.1	NA	+0.9	NA
B. Distribution				
Consumer surplus*	Δlevel (per household, $)			
Wealth: Q1	+9,754		+9,382	
Wealth: Q2	+12,683		+11,839	
Wealth: Q3	+6,858		+5,302	
Wealth: Q4	+1,862		−2,676	

Note: The table presents the changes compared to the values in the baseline model.
* The consumer surplus is calculated as in Table 6.

Again, taking into account nursing home reactions is important for policy evaluation. Comparisons between the first two columns (without nursing home reactions) and the last two columns (new equilibrium) reveal that missing the nursing home reactions results in an over-estimation of the increase in the consumer surplus (by missing the reduction in the nursing home care intensity) and over-estimation of the increase in the Medicaid expenditure (by missing the people leaving the Medicaid nursing home option due to lower care intensity). Moreover, in equilibrium, households in the top wealth quartile lose from this policy.

De Nardi et al. (2016) and Braun et al. (2017) also examine changes in Medicaid generosity. Our finding that the cost associated with more generous Medicaid is almost at par with the gains for households are in line with De Nardi et al. (2016). In contrast, Braun et al. (2017) find that the benefits of the expansion outweigh its costs. In particular, in their simulation, every household, even wealthy ones, benefits from this change. In our model, all the households benefit only when we do not take into account the nursing home responses. When nursing homes respond to this policy by reducing the care intensity, it hurts the households in the top wealth quartile. We conclude that capturing the equilibrium effects is important when evaluating the distributional effects of social insurance policies.

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 welfare and distributional effects of policies that target the demand side of the market, it is important to take into account nursing home responses to the policies. The experiments also reveal that providing subsidies for using in-home care for individuals without family help is a welfare-enhancing policy. The subsidies significantly increase the welfare of older individuals with a limited increase in Medicaid expenditures. The key behind this success is that such subsidies make individuals face the marginal cost of care by allowing them to choose out-of-pocket in-home care instead of being Medicaid enrollees. A small amount of subsidy ($10K per year) makes many individuals leave the Medicaid nursing home option to choose out-of-pocket in-home care. For each individual making this switch, Medicaid saves a large reimbursement to a nursing home, which is more than seven times the amount of the subsidy.

Although our framework is a step forward in the analyses of LTC policies, we recognize its limitations and plan to address them in the future. While our model captures rich heterogeneity on the household side—in age, income, wealth, health, and family status—for tractability, we abstract 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.

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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:

$$\begin{aligned} \pi_{ij,t} &= Pr(h_{t+1} = j | h_t = i) \\ &= \gamma_{ij} / \sum_k \gamma_{ik}, \\ \gamma_{iD} &= 1, \ \ \forall i, \\ \gamma_{ik} &= exp(x_{h_t=i}\beta_k), \ k \in \{ADLH, ADLL, Fair, Good\}, \end{aligned} \tag{26}$$

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: Detailed Outcomes from the Policy Experiments

B.1 Uniform Lump-sum In-home Care Subsidy

Table B1 reports the details of the impact of the lump-sum in-home care subsidy on LTC demand, with and without nursing home responses.

Table B1: Uniform lump-sum in-home care subsidy: effects on household care choices

A. Without NH response	Care type choice (%)				Mean intensity
	In-home care		Nursing Home		(hours per year)
	Private	Medicaid	Private	Medicaid	All
With family	61.5	16.8	4.6	17.1	2,456
	+0.4	−0.1	−0.2	−0.1	+2
Without family	45.1	18.8	16.5	19.6	2,099
	+13.6	−4.1	−5.3	−4.2	−130
Wealth: Q1	16.7	41.0	0.0	42.3	1,739
	+3.3	−1.6	0.0	−1.7	−52
Wealth: Q2	84.5	7.0	2.1	6.4	1,030
	+2.8	+0.8	−0.4	−1.3	−45
Wealth: Q3	81.0	0.0	18.8	0.0	1,859
	+4.8	0.0	−4.8	0.0	−33
Wealth: Q4	79.5	0.0	20.5	0.0	7,030
	+2.0	0.0	−2.0	0.0	+114
B. With NH response	Care type choice (%)				Mean intensity
	In-home care		Nursing Home		(hours per year)
	Private	Medicaid	Private	Medicaid	All
With family	61.3	15.6	4.3	18.7	2,485
	+0.2	−1.3	−0.4	+1.5	+31
Without family	46.1	17.2	15.4	21.3	2,127
	+14.5	−5.7	−6.3	−2.5	−101
Wealth: Q1	16.3	37.6	0.0	46.0	1,806
	+2.9	−4.9	−0.0	+2.0	+15
Wealth: Q2	84.4	6.7	1.5	7.3	1,042
	+2.7	−1.5	−1.0	−0.3	−33
Wealth: Q3	82.8	0.1	17.0	0.1	1,873
	+6.5	+0.0	−6.5	+0.0	−18
Wealth: Q4	79.1	0.0	20.9	0.0	7,015
	+1.6	0.0	−1.6	0.0	+99

Note: This table includes all individuals who need help with ADLs. 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 column).

B.2 Alternative In-home Care Subsidies

This Appendix reports the details for the outcomes under the alternative in-home care subsidies.

Table B2 shows the changes in household demand with and without nursing home responses under the phased-out in-home care subsidy. Table B3 shows the impact of the phased-out in-home care subsidy on nursing homes. Table B4 reports the impact of the phased-out in-home care subsidy on the consumer and producer surpluses as well as the Medicaid expenditures.

Table B5 shows the changes in household demand with and without nursing home responses under the proportional in-home care subsidy. Table B6 shows the impact of the proportional in-home care subsidy on nursing homes. Table B7 reports the impact of the proportional in-home care subsidy on the consumer and producer surpluses as well as the Medicaid expenditures.

Table B2: Phased-out in-home care subsidy: effects on household care choices

A. Without NH response	Care type choice (%)				Mean intensity
	In-home care		Nursing Home		(hours per year)
	Private	Medicaid	Private	Medicaid	All
With family	61.3	16.9	4.8	17.1	2,454
	+0.1	−0.0	−0.0	−0.1	−0
Without family	38.0	20.0	21.1	20.9	2,125
	+6.5	−2.9	−0.7	−2.9	−103
Wealth: Q1	16.6	41.0	0.0	42.4	1,738
	+3.2	−1.6	+0.0	−1.6	−53
Wealth: Q2	83.1	7.5	2.5	7.0	1,042
	+1.3	−0.7	+0.0	−0.7	−33
Wealth: Q3	76.7	0.1	23.1	0.1	1,899
	+0.5	+0.0	−0.5	+0.0	+8
Wealth: Q4	77.8	0.0	22.2	0.0	6,949
	+0.3	0.0	−0.3	0.0	+32
B. With NH response	Care type choice (%)				Mean intensity
	In-home care		Nursing Home		(hours per year)
	Private	Medicaid	Private	Medicaid	All
With family	61.1	16.5	4.7	17.6	2,451
	+0.0	−0.5	−0.0	+0.5	−3
Without family	38.3	19.4	20.8	21.5	2,295
	+6.7	−3.4	−1.0	−2.3	+67
Wealth: Q1	16.5	39.9	0.0	43.6	1,776
	+3.1	−2.7	−0.0	−0.4	−15
Wealth: Q2	83.0	7.4	2.3	7.3	1,070
	+1.3	−0.8	−0.1	−0.4	−5
Wealth: Q3	77.2	0.0	22.6	0.0	1,888
	+0.9	+0.0	−1.0	+0.0	−4
Wealth: Q4	77.5	0.0	22.5	0.0	7,064
	−0.0	0.0	+0.0	0.0	+148

Note: This table includes all individuals who need help with ADLs. 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 column).

Table B3: Phased-out in-home care subsidy: effects on nursing homes

	Baseline	No NH response		NH response	
		Δ	Δ%	Δ	Δ%
NH care intensity (Q, hours per year)	2,000	0	0	+36	+1.8
NH price (P, \$K)	85.0	0	0	+1.3	+1.5
Marginal cost (\$K)	69.8	−0.7	−1.0	+0.5	+0.7
Private residents	40.4	−0.1	−0.1	−0.7	−1.7
Medicaid residents	64.3	−2.3	−3.6	−0.4	−0.6
NH private revenue (\$M)	3.44	−0.01	−0.3	−0.01	−0.3
NH Medicaid revenue (\$M)	4.92	−0.18	−3.6	−0.03	−0.6
NH Profits (\$M)	1.87	−0.03	−1.6	−0.02	−1.1
NH residents on Medicaid (%)	61.3	−0.7	−1.1	+0.4	+0.7

Notes: Panel A tabulates the changes in the LTC demand among the individuals without family help. Panel B tabulates the changes for each nursing home.

Table B4: Phased-out in-home care subsidy: welfare evaluations with and without nursing home responses

A. Aggregates	No NH response		NH response	
	Δlevel (\$M)	Δ%	Δlevel (\$M)	Δ%
Consumer surplus*	+2.6	NA	+2.6	NA
Producer surplus	−0.3	−1.6	−0.2	−1.1
Medicaid savings	+2.1	+2.7	+0.5	+0.6
Nursing home care	+1.9	+3.5	+0.3	+0.6
In-home care	+3.6	+7.9	+3.4	+7.4
Transfers	−3.4	−15.7	−3.2	−14.8
Total	+4.4	NA	+2.9	NA
B. Distribution				
Consumer surplus* by wealth groups	Δlevel (per household, \$)		Δlevel (per household, \$)	
Wealth: Q1	+776		+841	
Wealth: Q2	+1,679		+1,793	
Wealth: Q3	+1,916		+1,869	
Wealth: Q4	+856		+842	

Note: The table presents changes compared to the values in the baseline economy.
* 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.

Table B5: Proportional in-home care subsidy: effects on household care choices

A. Without NH response	Care type choice (%)				Mean intensity (hours per year)
	In-home care		Nursing Home		
	Private	Medicaid	Private	Medicaid	All
With family	61.2	16.9	4.7	17.2	2,457
	+0.1	−0.0	−0.1	−0.0	+3
Without family	34.8	22.5	19.2	23.5	2,300
	+3.2	−0.4	−2.5	−0.3	+71
Wealth: Q1	13.6	42.5	0.0	43.9	1,789
	+0.1	−0.1	−0.0	−0.0	−2
Wealth: Q2	82.2	8.0	2.3	7.5	1,073
	+0.5	−0.2	−0.1	−0.2	−2
Wealth: Q3	78.3	0.0	21.6	0.0	1,892
	+2.0	+0.0	−2.0	+0.0	+0
Wealth: Q4	78.9	0.0	21.1	0.0	7,063
	+1.4	0.0	−1.4	0.0	+146
B. With NH response	Care type choice (%)				Mean intensity (hours per year)
	In-home care		Nursing Home		
	Private	Medicaid	Private	Medicaid	All
With family	61.1	16.9	4.7	17.6	2,464
	−0.0	−0.0	−0.0	+0.5	+10
Without family	34.8	22.0	19.1	24.0	2,311
	+3.3	−0.1	−2.6	+0.2	+82
Wealth: Q1	13.5	41.5	0.0	45.0	1,807
	+0.1	−1.1	−0.0	+1.0	+16
Wealth: Q2	82.1	7.9	2.2	7.8	1,077
	+0.4	−0.3	−0.2	+0.1	+2
Wealth: Q3	78.4	0.1	21.4	0.1	1,898
	+2.2	+0.0	−2.2	+0.0	+5
Wealth: Q4	78.6	0.0	21.4	0.0	7,057
	+1.0	0.0	−1.0	0.0	+141

Note: This table includes all individuals who need help with ADLs. 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 column).

Table B6: Proportional in-home care subsidy: effects on nursing homes

	Baseline	No NH response		NH response	
		Δ	Δ%	Δ	Δ%
NH care intensity (Q, hours per year)	2,000	0	0	+36	+1.8
NH price (P, \$K)	85.0	0	0	+0.8	+0.9
Marginal cost (\$K)	69.8	−0.6	−0.9	+0.3	+0.4
Private residents	40.4	−2.7	−7.0	−2.8	−6.9
Medicaid residents	64.3	−0.3	−0.5	+1.4	+2.2
NH private revenue (\$M)	3.44	−0.24	−7.0	−0.22	−6.4
NH Medicaid revenue (\$M)	4.92	−0.03	−0.5	+0.11	+2.2
NH Profits (\$M)	1.87	−0.05	−2.7	−0.06	−3.2
NH residents on Medicaid (%)	61.3	+1.6	+2.6	+2.3	+3.8

Notes: Panel A tabulates the changes in the LTC demand among the individuals without family help. Panel B tabulates the changes for each nursing home.

Table B7: Proportional in-home care subsidy: welfare evaluations with and without nursing home responses

A. Aggregates	No NH response		NH response	
	Δlevel (\$M)	Δ%	Δlevel (\$M)	Δ%
Consumer surplus*	+4.2	NA	+4.5	NA
Producer surplus	−0.6	−2.7	−0.7	−3.2
Medicaid savings	−3.3	−4.2	−3.8	−4.9
Nursing home care	+0.2	+0.4	−1.2	−2.2
In-home care	+0.4	+0.9	+1.1	+2.4
Transfers	−3.9	−18.4	−3.7	−17.1
Total	+0.3	NA	0.0	NA
B. Distribution				
Consumer surplus* by wealth groups	Δlevel (per household, \$)		Δlevel (per household, \$)	
Wealth: Q1	+147		+170	
Wealth: Q2	+359		+432	
Wealth: Q3	+1,125		+1,200	
Wealth: Q4	+6,904		+7,352	

Note: The table presents changes compared to the values in the baseline economy.

* 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.

B.3 Changes in Medicaid Generosity

Table B8 reports the impact of decreasing Medicaid generosity on the nursing homes.

Table B8: Decreasing Medicaid generosity: effects on nursing homes

	Baseline	No NH response		NH response	
		Δ	Δ%	Δ	Δ%
NH care intensity (Q, hours per year)	2,000	0	0	+113	+5.7
NH price (P, \$K)	85.0	0	0	+0.9	+1.0
Marginal cost (\$K)	69.8	−3.4	−4.9	+0.6	+0.9
Private residents	40.4	−0.3	−0.1	+1.6	+4.0
Medicaid residents	64.3	−11.6	−18.0	−6.8	−10.6
NH private revenue (\$M)	3.44	−0.03	−0.1	+0.17	+4.9
NH Medicaid revenue (\$M)	4.92	−0.89	−18.0	−0.52	−10.6
NH Profits (\$M)	1.87	−0.11	−5.9	−0.13	−7.0
NH residents on Medicaid (%)	61.3	−4.5	−7.3	−3.5	−5.7

Notes: Panel A tabulates the changes in the LTC demand among the individuals without family help. Panel B tabulates the changes for each nursing home.

Table B9 reports the details of the impact of the increased Medicaid generosity on LTC demand, with and without nursing home responses.

Table B10 reports the details of the impact of the decreased Medicaid generosity on LTC demand, with and without nursing home responses.

Table B9: Medicaid generosity increase: effects on household care choices

A. Without NH response	Care type choice (%)				Mean intensity
	In-home care		Nursing Home		(hours per year)
	Private	Medicaid	Private	Medicaid	All
With family	54.9	19.4	4.8	20.9	2,561
	−6.3	+2.4	+0.0	+3.8	+107
Without family	26.9	24.9	22.1	26.1	2,309
	−4.7	+2.1	+0.3	+2.4	+80
Wealth: Q1	5.0	45.7	0.0	49.4	1,928
	−8.5	+3.1	−0.0	+5.4	+137
Wealth: Q2	73.6	11.9	2.4	12.1	1,201
	−8.1	+3.7	−0.0	+4.4	+126
Wealth: Q3	75.1	0.2	24.5	0.2	1,941
	−1.1	+0.1	+0.9	+0.1	+50
Wealth: Q4	77.6	0.0	22.4	0.0	6,953
	+0.0	0.0	−0.1	0.0	+36
B. With NH response	Care type choice (%)				Mean intensity
	In-home care		Nursing Home		(hours per year)
	Private	Medicaid	Private	Medicaid	All
With family	55.8	21.0	4.3	19.0	2,533
	−5.4	+4.0	−0.4	+1.8	+79
Without family	28.0	27.2	21.1	23.7	2,250
	−3.5	+4.3	−0.7	−0.1	+21
Wealth: Q1	5.1	49.8	0.0	45.0	1,864
	−8.3	+7.3	−0.0	+1.0	+73
Wealth: Q2	74.4	12.6	2.4	10.7	1,174
	−7.3	+4.4	−0.1	+3.0	+100
Wealth: Q3	76.5	0.2	23.1	0.2	1,910
	+0.3	+0.1	−0.5	+0.1	+18
Wealth: Q4	79.7	0.0	20.3	0.0	6,972
	+2.2	0.0	−2.2	0.0	+56

Note: This table includes all individuals who need help with ADLs. 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 column).

Table B10: Medicaid generosity decrease: effects on household care choices

A. Without NH response	Care type choice (%)				Mean intensity
	In-home care		Nursing Home		(hours per year)
	Private	Medicaid	Private	Medicaid	All
With family	65.7	15.1	4.7	14.4	2,373
	+4.6	−1.8	−0.0	−2.8	−81
Without family	34.9	21.7	21.3	22.2	2,171
	+3.3	−1.2	−0.5	−1.6	−58
Wealth: Q1	22.0	39.4	0.0	38.6	1,646
	+8.6	−3.2	+0.0	−5.3	−145
Wealth: Q2	84.6	6.7	2.5	6.1	1,027
	+2.9	−1.4	+0.0	−1.5	−48
Wealth: Q3	77.2	0.0	22.7	0.0	1,862
	+0.9	−0.0	−0.9	−0.0	−30
Wealth: Q4	77.5	0.0	22.5	0.0	6,903
	−0.0	0.0	+0.1	0.0	−14
B. With NH response	Care type choice (%)				Mean intensity
	In-home care		Nursing Home		(hours per year)
	Private	Medicaid	Private	Medicaid	All
With family	65.1	14.2	5.1	15.6	2,393
	+4.0	−2.7	+0.3	−1.6	−61
Without family	34.1	20.1	21.9	23.8	2,218
	+2.6	−2.7	+0.2	+0.0	−11
Wealth: Q1	21.6	36.8	0.0	41.6	1,699
	+8.2	−5.8	+0.0	−2.4	−92
Wealth: Q2	84.2	6.5	2.5	6.8	1,039
	+2.5	−1.7	+0.1	−0.9	−35
Wealth: Q3	76.4	0.0	23.5	0.0	1,885
	+0.2	−0.0	−0.1	−0.0	−7
Wealth: Q4	75.8	0.0	24.2	0.0	6,889
	−1.7	0.0	+1.7	0.0	−28

Note: This table includes all individuals who need help with ADLs. 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 column).