Save, Spend or Give? A Model of Housing, Family Insurance, and Savings in Old Age

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Abstract

We propose that interactions among old-age risks, housing, and family insurance are key for understanding the economic behavior of the elderly. Empirically, we find that homeownership reduces dis-saving while increasing the likelihood and persistence of informal care from children, which in turn protects bequests by preventing nursing home entry. Nonetheless, elderly parents and the childless display strikingly similar savings and bequests. Additionally, we calculate that one-fourth of transfers from retired parents to children flow before death. We build a dynamic model featuring strategic interactions between imperfectly-altruistic parent and child households, a housing choice, and long-term-care risk. The model successfully rationalizes our empirical findings. Homes are valuable for inducing care from children, accounting for 10% of ownership. Although the childless have no altruistic motive for saving, they resemble parents because they lack family insurance and thus have a stronger precautionary motive. Parents withhold most transfers until death for strategic reasons.

Keywords: consumption/saving/wealth of the elderly, family insurance, intergenerational transfers, dynamic game

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1 Introduction

Understanding old-age economic behavior has become increasingly important for public policy and in the design of financial products for the elderly. However, several features of the data have proven challenging to rationalize in existing models. It is well-documented, for instance, that the elderly in the U.S. decumulate their wealth relatively slowly and often leave sizable bequests (De Nardi et al., 2016). A closely related observation is that the elderly typically own their homes and tend not to sell unless faced with a serious health event—e.g., needing long-term care (LTC)—or the death of a spouse (Venti & Wise, 2004). Because a household's wealth usually passes to its children when the last member of the household dies, these facts seem to suggest an altruistic motive for bequests. However, the savings and bequest behavior of childless households in the U.S. closely resembles that of parents (Hurd, 1989; Dynan et al., 2004; Kopczuk & Lupton, 2007), a finding that has often been interpreted as evidence against altruism. Yet, the presence of children entails more than altruism alone: the elderly face large uninsured risks, such as the need for long-term care (Brown & Finkelstein, 2011), and family often provides an important source of support (Barczyk & Kredler, 2018; Ko, 2018). Finally, in addition to disentangling the motives behind inter-generational transfers, explaining their timing—the fact that most, but not all, transfers from parents to children are delayed until a parent's death (Gale & Scholz, 1994; Kopczuk, 2007)—poses yet another challenge.

In this paper, we put forward a framework to rationalize these salient and interrelated aspects of the data. We find that *interactions* between old-age risks, family insurance, and housing are critical for making sense of these facts. In order to sharpen our intuition about the nature of these interactions, consider the following example. An elderly widower contemplates whether to sell his house; he has few other financial assets, but a decent Social Security pension. Selling his house would enable him to consume more. However, if he were to require care, keeping the house would make care from his daughter more likely; otherwise, he would need to sell his home to pay for a nursing home, and less wealth would be left over for her. Also, he may never require care, and if he were to die unexpectedly, the thought that the house will belong to his daughter reassures him. So, he keeps the house and commits to a lower consumption profile. But, why not transfer ownership now in return for future care? By not ceding control over his wealth, he avoids putting himself in a vulnerable position while still retaining the ability to help his daughter out financially, should the need arise.

We first establish a set of descriptive facts on old-age economic behavior using the Health and Retirement Study (HRS). Although some of the separate facts we document on the relationships between savings behavior and the presence or absence of children, homeownership, and the use of nursing home care are known in the literature, we present new evidence here on the role of informal caregiving and on how these different elements interact. First, and seemingly speaking against the importance of the family, we find that households without children hold similar levels of wealth and display similar savings patterns to households with children.[1] Second, elderly homeowners decumulate their wealth little, if at all, while renters run down their wealth faster. Also, the liquidation of housing assets is an important form of dissaving for the elderly and often takes place when entering a nursing home.[2] Third, nursing home residents spend down wealth much faster than the elderly who reside in the community. Fourth, most inter-generational transfers in old age are delayed and flow in the form of bequests.

We provide new evidence on the interactions between these different elements. We find that a) single elderly without children are more likely to enter nursing homes than single elderly with children. The latter receive informal care more often, in the overwhelming number of cases from their children. Relatedly, our results show that b) households without children hold more liquid wealth than those with children and that they are less likely to be homeowners. In addition, c) homeowners are more likely to be cared for by a child even when controlling for other co-variates, and moreover, d) these informal care arrangements are more long-lived among owners than renters. Relatedly, we observe that e) homeowners who receive informal care spend down their wealth at a slower pace than renters who receive informal care. Finally, we document that f) parents of caregiving children leave larger bequests, both when we consider housing assets alone and when we consider the overall size of the estate.

On the basis of this descriptive evidence, we construct a dynamic model with imperfectly-altruistic agents. In the model, a parent household and a child household make separate consumption-savings decisions and interact strategically. Housing is modeled as an illiquid asset that delivers a flow of housing services that are superior to those delivered by the rental market. The parent faces disability risk (LTC risk) in retirement. When disabled, LTC needs can be covered by one of the following options: (i) informal care from the child, who faces an opportunity cost in the labor market; (ii) formal care at home; (iii) privately-paid nursing home care; or (iv) a means-tested, government-provided consumption floor, which we interpret as Medicaid-sponsored nursing home care. The parent and child bargain period-by-period on the informal care and house-selling decisions. They have access to contemporaneous side payments, which we interpret as exchange-

[1]Hurd (1989) finds that households with and without children display similar savings behavior and interprets this as evidence against a bequest motive. Dynan et al. (2004) find that, if anything, the saving rates of households without children are higher. They interpret this as evidence against the dynastic model as in Becker & Tomes (1986) where bequests arise in order to smooth dynastic consumption. In contrast, Kopczuk & Lupton (2007) argue that a significant portion (three-quarters) of elderly households—both with and without children—behave in a manner consistent with a bequest motive.

[2]This mirrors findings by Venti & Wise (2004) and Davidoff (2010). They find that giving up ownership is most often associated with the death of a spouse or entry into a nursing home. Home equity is rarely used to support non-housing consumption, and reverse annuity mortgages are also uncommon; see also, Nakajima & Telyukova (2017).

motivated inter-vivos transfers. The model also features altruistically-motivated transfers that flow without a quid-pro-quo. Importantly, both parent and child lack the ability to commit to future actions (concerning consumption, care, and transfers).

We now explain some of the key mechanisms in the model that rationalize the features of the data described above. First, our model provides a novel quantitative explanation for why parents and childless households in the U.S. exhibit similar savings and bequests. Since the childless cannot count on family insurance (either through informal care or through financial transfers from their children), they face larger risks and therefore accumulate higher precautionary savings, which they leave as (unintended) bequests. This channel turns out to be just as strong as the incentives that parents have to save for altruistic bequests and as a bargaining chip for informal care.

Second, our model accounts for the observed differences in savings behavior between homeowners and renters. Through the lens of the model, selection of households into owning accounts for about half of these differences; the other half is due to the causal effect of homeownership on savings behavior. Homeowners in the model dis-save more slowly than otherwise equal renters since i) housing offers a superior return to financial assets and ii) housing is illiquid. Consistent with the data, the model predicts that about half of all homeowners liquidate their homes during retirement and that many of these liquidations occur when the elderly enter nursing homes. Our model allows us to structurally estimate the share of home liquidations that are triggered directly by disability shocks; we calculate this figure to be 60%.

Third, our model features a novel channel that connects housing, LTC risk, and the family. In particular, housing acts as a commitment device that enables families to implement and prolong informal caregiving arrangements. This channel accounts for about 10% of the homeownership rate in the model. It works as follows. If the child does not give care to a disabled, home-owning parent, the parent is forced to sell the house to finance a nursing home stay, which entails a faster spend-down of the parent's wealth and thus lowers the child's bequest. If the child provides care, however, the parent can credibly commit to a low consumption profile. The parent can do so because the home offers valuable services that substitute for other consumption; in addition, the illiquidity of housing bounds the parent's net worth below at the value of the house. This mechanism can keep the promise of a sizable bequest intact for a long time and thus support informal caregiving arrangements for longer than would be possible for otherwise identical renters.[3]

Finally, our model provides us with a rationale for why most, but not all, transfers are delayed and given as bequests. Since altruism is imperfect and there is no commitment, parents do not transfer wealth prematurely to children. Were a parent to cede control of her assets to her children,

[3] In our model, renters have to compensate their children for caregiving with higher contemporaneous transfers and choose—individually optimally—higher consumption expenditures. As a result, renters run down their assets more rapidly, leading to more short-lived informal care arrangements.

they would not act in the parent's best interest: they would assign lower consumption and cheaper care arrangements to the parent than the parent herself would choose. Nevertheless, parents still give inter-vivos transfers in exchange for care and for altruistic reasons (when the child is in need). Our model predicts that one-fourth of all parent-to-child transfers after retirement are inter-vivos, which is in line with the numbers provided by Gale & Scholz (1994) and slightly higher than what we find in the HRS (one-fifth).

Related literature Our paper contributes to several literatures on old age and housing. A large literature has focused on the savings behavior of the elderly, with an emphasis on understanding why the elderly spend down their wealth more slowly than the standard life-cycle model predicts (the *retirement-savings puzzle*).[4] The most recent papers have attributed central importance to health-expenditure risks. Our model includes this element in the form of medical and LTC expenditure risk but also adds a source of family insurance in the form of time and money transfers from children, following Barczyk & Kredler (2018).[5] Additionally, in our theory of the family, there are also several channels for inter-vivos transfers which have been argued to be important drivers behind the savings behavior of elderly parents.[6] By explicitly modeling the various channels through which family insurance operates, we break from the existing structural literature by making an explicit distinction between the economic environments facing parents and childless households. We believe that the results we obtain from this approach can point to new economic insights and potentially useful ways of identifying models.

Another strand of the literature on the retirement-savings puzzle argues for the importance of the *egoistic* bequest motive (also referred to as warm glow or joy-of-giving) for explaining the savings of the elderly. Here, a bequest is conceptualized as a consumption good, which yields utility in proportion only to the size of the bequest. Recent estimates from Lockwood (2018) suggest that bequests in such a specification are luxury goods. Additional free parameters (the strength of the warm glow and the curvature) help in achieving a good fit of old-age savings patterns. A shortcoming of this theory is that it assumes away inter-vivos transfers, although they do occur in the data.[7] A key strength of our altruism model without commitment is that a very parsimonious

[4]See the excellent survey by De Nardi et al. (2016). There are three themes. (1) Lifetime uncertainty—e.g., Yaari (1965), De Nardi et al. (2009). (2) Bequest motives, which can be grouped into: (i) the *egoistic* motive, that households leave a bequest to increase their own utility—De Nardi (2004), Lockwood (2018); (ii) the *altruistic* motive, that the utility of the recipient plays a role in determining the bequest—Becker & Tomes (1986), Laitner (2002), Barczyk (2016); and (iii) the *strategic* motive, where individuals use bequests to influence the quantity of services provided to them by their children—Bernheim et al. (1985), Perozek (1998), Groneck (2016), Barczyk & Kredler (2018). (3) Uncertain medical expenditures—Palumbo (1999), Dynan et al. (2004), DeNardi et al. (2010), Kopecky & Koreshkova (2014), Dobrescu (2015).

[5]We discuss the relationship to this paper further below.

[6]A recent example is Boar (2018), who finds that parents engage in precautionary savings on behalf of their children to insure them against income risk.

[7]Including inter-vivos and time transfers would require stipulating a utility function for each type of transfer, resulting in a highly-parametrized model. Another shortcoming is in interpretation: warm glow is often interpreted

theory (a single altruism parameter) is enough to yield tight predictions on inter-vivos transfers, bequests, and their timing. Because the existing literature has remained largely silent on the timing of inter-generational transfers, this represents an important contribution of this paper.

A largely separate literature has sought to understand the extent to which retirees are willing to access their housing equity to finance non-housing consumption; see, e.g., Hurd (2002), Venti & Wise (2004), Yang (2009), Davidoff (2010), Nakajima and Telyukova (2017, 2018), Blundell et al. (2016). Overall, this literature finds that elderly homeowners are reluctant to draw down home equity except when faced with widowhood or nursing home entry, in which case the house tends be liquidated altogether.[8] Recent papers by Nakajima and Telyukova (2017, 2018) have incorporated housing into an old-age-savings model in a way similar to ours. They find that the interplay between home equity and the egoistic bequest motive plays a key role in understanding the savings behavior of retirees and the unpopularity of reverse mortgage products among this demographic. The key difference relative to our paper is that there is no family dimension in their theory, which we find interacts in important ways with homeownership and old-age risks.

Another recent related literature on households' consumption-savings decisions has introduced novel lines of thinking about housing as a special asset. Kaplan & Violante (2014), for example, find that many households—despite being wealthy—consume hand-to-mouth, as most of their assets are locked into a high-return illiquid asset. Similar to their framework, households in our model are reluctant to liquidate their homes but do so in response to sufficiently severe shocks. Additionally, housing in our model credibly constrains consumption and provides a commitment mechanism to save in the absence of formal contracts.[9] Davidoff (2010) argues that homeownership is a substitute for LTC insurance, a channel that is also present in our model: housing can be liquidated to finance increased expenditures when disabled.

Finally, we discuss how the model set-up in the current paper compares to previous work by Barczyk and Kredler. The strategic interaction between parents and children in saving decisions is similar to Barczyk and Kredler (2014a, 2014b). Barczyk & Kredler (2018) also include a time transfer (informal care) alongside financial transfers. New in this paper are the following ingredients. First, and foremost, we include a model of housing and a joint bargaining decision on the care arrangement and the parent's house-selling decision. This is a non-trivial extension since housing

as a short-cut to altruism towards children in the literature, but Kopczuk & Lupton (2007) find that it also encodes concerns that are unrelated to one's children. In a survey of this literature, De Nardi et al. (2016) argue that future work should study in more detail the interplay between old-age risks and (the) bequest motive(s), which is what we do here.

[8]Others have found modest reliance on home equity. For instance, Sinai & Souleles (2007) show that the younger elderly increase housing debt when house prices rise though some of this is re-invested.

[9]The mechanics resemble what Chetty & Szeidl (2007) describe as *ex ante* consumption commitments where only large shocks lead to changes in the commitment good. The idea of committing oneself to a certain good with desirable outcomes is also present in the self-control and temptation literature (e.g., Gul & Pesendorfer, 2004), where we can think of purchasing a house as a way for households to limit their consumption (the temptation good).

is a discrete permanent choice, which entails several challenges for theory and computation. Second, we model formal care at home as a choice for covering LTC needs, separate from nursing homes and informal care. A third difference concerns the endogenous outcome of the game between parent and child: some agents give gifts even though the recipient has positive financial wealth, which did not occur in equilibrium in the previous papers. We show how to deal with such gifts computationally, which is important in the computational backward iteration of value functions.

The paper is structured as follows. Section 2 provides our empirical results. In Section 3, we present the model and describe its key characteristics. Section 4 discusses the calibration of the model, Section 5 analyzes the model fit, and in Section 6 we present the main quantitative results. Section 7 concludes.

2 Empirical facts

We first study empirically the economic behavior of the elderly. We focus in particular on savings patterns across different configurations of family, housing, and long-term care arrangements. For this analysis, we utilize data from the Health and Retirement Study (HRS), a longitudinal survey of U.S. households with a member over the age of 50, which is known to be representative of the bottom 95% of the wealth distribution for these older households. Although it does not capture the top of the wealth distribution, the length of the HRS panel and the fact that the HRS surveys nursing home residents makes the HRS more suitable for our purposes than alternative surveys, such as the Survey of Consumer Finances.

Our analyses draw upon data from core interviews in the 1998-2010 survey waves of the HRS in addition to data from exit interviews occurring in the years 2004-2012. Notably, these exit interviews contain data on realized bequests. For our analyses of these estate data, we restrict attention to individuals who were single at the time of death in order to focus on inter-generational transfers rather than transfers between spouses. Appendix A provides additional details about the data, including sample selection and the construction of particular variables. Appendix C explains how we impute missing estate values.

2.1 Wealth and estate distributions

We first consider the cross-sectional distributions of estates and net worth. Panel (a) of Table 1 reports the distribution of net worth around retirement age for HRS respondent households whose eldest member is aged 65-69. Panel (b) presents the distribution of the estates among single decedents. The statistics in each panel are reported for all households and also for households with and without children separately. An immediate first observation is that the distributions of both net worth and estates are highly skewed. For instance, while the median estate in Panel (b) is only $20,000, the mean is $226,000.[10] A second observation is the striking similarity between parents and childless households. Decedents without children appear to hold as much, if not more, wealth at the end of life than parents. Net worth earlier in life, at the ages 65-69, is also similar between these two groups. Indeed, when one considers the fact that individuals in households without children are more likely to be single, the results in Table 1 suggest that, on a *per capita* basis, individuals without children tend to hold more wealth than parents.

Table 1: Estate and net worth distributions

(a) Net worth (all respondents, ages 65-69)

	N	Mean	p10	p25	p50	p75	p90	p95
Children	13,568	558	2	54	206	553	1,229	1,966
No Children	1,008	501	0	34	206	651	1,102	1,685
All	14,576	553	2	53	206	560	1,212	1,919

(b) Estates (single decedents)

	N	Mean	p10	p25	p50	p75	p90	p95
Children	2,803	230	0	0	22	198	521	806
No Children	355	205	0	0	13	198	639	1,043
All	3,158	226	0	0	20	198	521	834

Panel (a): HRS core interviews 1998-2010. All HRS respondent households whose eldest member is aged 65-69 during this period. Respondent-level weights are used. For couples, one observation is selected per household per interview. Panel (b): HRS exit interviews 2004-2012. Decedents who at time of death were neither married nor partnered. Child status is determined according to the number of children listed at the exit interview. Respondent-level weights from the last core interview available are used. In both panels, dollar values are in 1000s of year-2010 dollars.

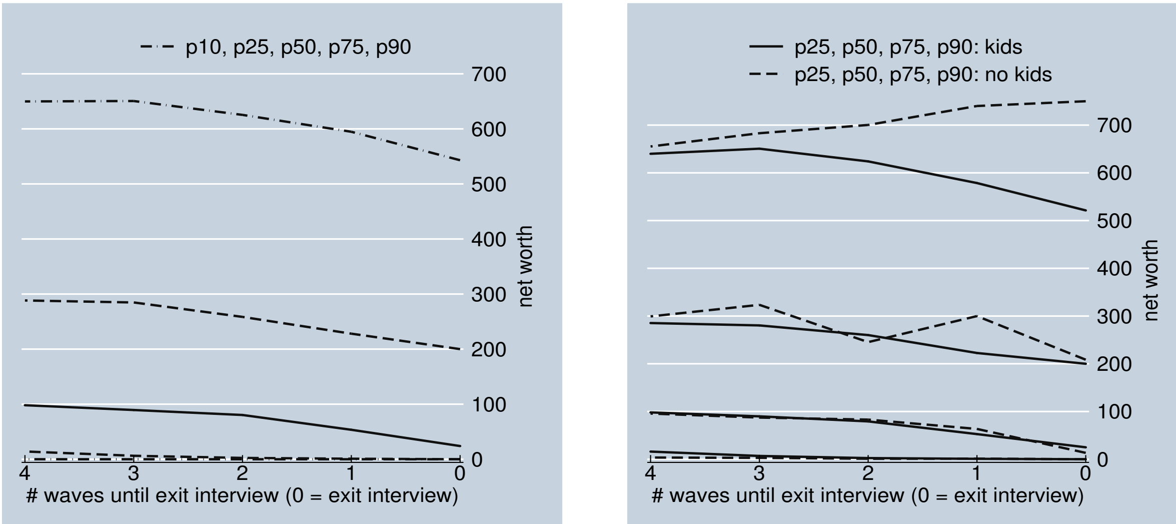
2.2 Wealth trajectories near the end of life

We now turn our focus from the level of wealth to the rate at which wealth is spent down and the main variables that determine how fast this happens. Figures 1-3 present wealth trajectories for our sample of single decedents in the period leading up to their deaths. On average, the period spanned by these figures covers roughly 7.5 years.[11] The figures are drawn for a balanced panel of

[10] In Appendix D, we show that the right tail of the estate distribution follows a Pareto (power-law) distribution for estates above approximately $450,000. Our estimate for the power-law coefficient implies that while the mean exists, higher moments do not. This implies that the Central Limit Theorem does not apply, which makes any estimates relying on central moments (such as means and regression coefficients) extremely sensitive to outliers. We thus carry out our analysis relying on quantiles and regressions in logarithms.

[11] The span of time covered by the figures varies across individuals because of variations in the timing of interviews and the fact that some individuals return to the sample after missing one or more interviews.

Figure 1: Wealth trajectories



(a) All

(b) With and without children

HRS core interviews 1998-2010 and exit interviews 2004-2012. Sample of single decedents. Wealth percentiles 10, 25, 50, 75 and 90 are reported at 4, 3, 2, and 1 interview-waves prior to the exit interview and at the exit interview (= 0). Panel (a) is for the full sample, and Panel (b) differentiates between those with and without children based on the number of living children listed in the exit interview. Dollar values are 1000s of year-2010 dollars. Respondent-level weights are used. Figures are constructed with balanced panels.

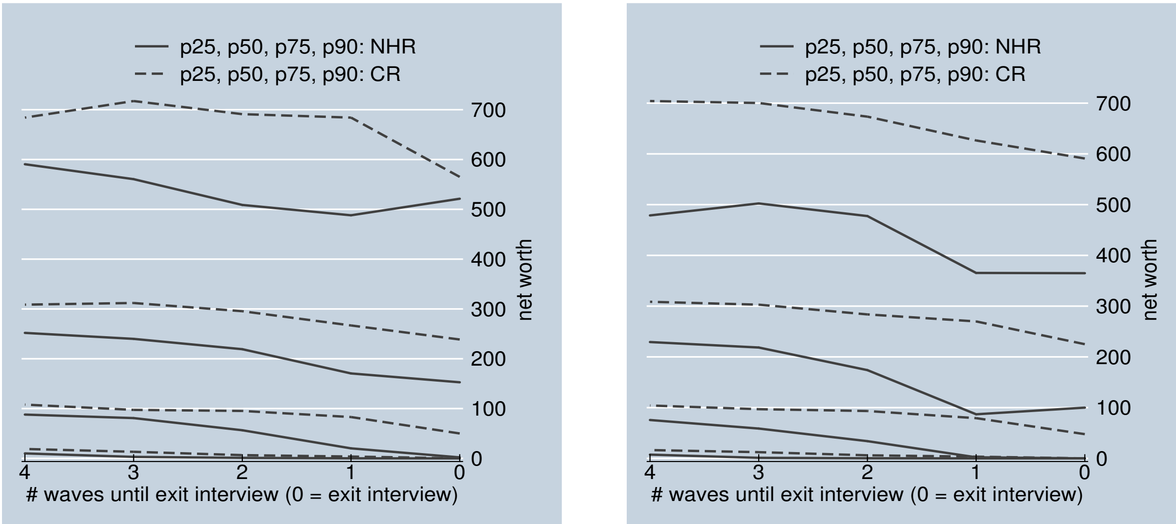
individuals, so the composition of the sample is held constant within each figure.

Panel (a) of Figure 1 shows the wealth trajectories for all single decedents. The figure reveals considerable asset dis-accumulation near the end of life. The median individual in our sample holds just under $100,000 in the fourth core interview prior to death but leaves an estate valued at only $20,000. This change represents an 80% decline in wealth in less than eight years. Declines of a similar absolute magnitude can be seen at higher wealth quantiles as well although in relative terms the dis-savings rates of the very wealthy are much lower. By focusing on the period leading up to death, the figure provides sharper evidence of wealth dis-accumulation than has been reported in much of the prior research on savings behavior in old age.

In Panel (b) of Figure 1, we divide the decedent sample into individuals with and without children. Consistent with the evidence on wealth and estates presented in Table 1, the trajectories are strikingly similar, both in terms of the levels of wealth and the rate of spend-down. This evidence confirms the results in prior research that found similar savings rates between parents and childless individuals and complements this work by providing new corroborating evidence that these patterns persist even at the end of life.

Central to our explanation of the similar savings behavior of those with and without children are the greater risks faced by childless individuals in old age, the most salient of which being the risk of needing long-term care. Within our sample of decedents, there are indeed large differences

Figure 2: Wealth trajectories by nursing home status

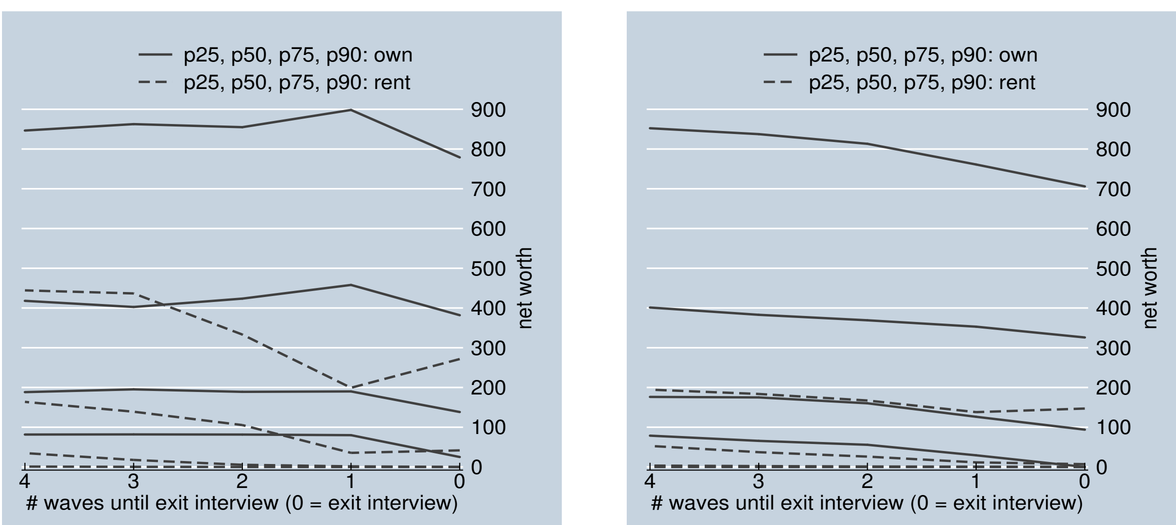


(a) NHR or CR in last three months of life

(b) NHR or CR in last wave prior exit

HRS core interviews 1998-2010 and exit interviews 2004-2012. Sample of single decedents. Wealth percentiles 25, 50, 75 and 90 are reported at 4, 3, 2, and 1 interview-waves prior to the exit interview and at the exit interview (= 0). NHR means nursing home resident and CR stands for community resident. In part (a), nursing home status is from the exit interview and refers to the last three months of life. In part (b) nursing home status is recorded at the time of the last core interview. Dollar values in terms of year 2010. Respondent-level weights are used. Figures are constructed with balanced panels.

Figure 3: Wealth trajectories by homeownership



(a) Own or rent in last wave prior exit

(b) Own or rent in fourth wave prior exit

HRS core interviews 1998-2010 and exit interviews 2004-2012. Sample of single decedents. Wealth percentiles 25, 50, 75 and 90 are reported at 4, 3, 2, and 1 interview-waves prior to the exit interview and at the exit interview (= 0). Wealth trajectories are conditional on owning or renting at (a) the last core interview prior to death or (b) the fourth core interview prior to death. Dollar values in terms of year 2010. Respondent-level weights are used. Figures are constructed with balanced panels.

in the rates of nursing home utilization between parents and individuals without children. In the last 3 months of life, 51.3% of childless individuals and 40.9% of parents live in nursing homes. At the final core interview, which takes place on average (median) 14 months prior to death, 25.4% of childless individuals and 21.3% of parents live in nursing homes.

We show in Figure 2 that savings patterns are strongly related to these long-term care arrangements. Panel (a) plots wealth trajectories separately by whether the decedent lived in a nursing home or in the community in the final three months of life, and Panel (b) repeats this exercise using nursing home status from the final core interview. From the two panels, we see that nursing home residents, especially those who moved into a nursing home more than three months before their deaths, are considerably poorer than community residents. In addition, particularly in Panel (b), we see much more steeply negative wealth trajectories leading up to the final core interview for individuals in nursing homes relative to community residents.

We conclude this section by providing evidence on the importance of housing, which as we describe in more detail below, plays a critical supporting role in our theory. Figure 3 plots wealth trajectories separately for homeowners and renters (non-owners). Panel (a) divides the decedent sample based on homeownership in the final core interview prior to death while Panel (b) splits the sample by ownership in the fourth interview before death. Two patterns are immediately evident from the figure. First, homeowners are much wealthier than renters. Second, owners dis-save much more slowly than renters, and dis-saving for owners appears to occur only with the liquidation of housing wealth. Indeed, among those who retain ownership of their homes, we observe almost no asset dis-accumulation.

2.3 Interactions between family, LTC, and housing

We now elaborate on the relationships between the three key factors we identified above: family, long-term care, and housing. The discussion highlights the critical intermediary role that housing plays between long-term care (risk) and family (insurance).

We first document that individuals without children tend to hold less wealth in illiquid forms, such as housing. We provide this evidence in Table A1 in the Appendix, which reports non-housing financial wealth for parents and households without children at ages 65-69 and in the final core interview prior to death.[12] Both near the end of life and earlier in old age, holdings of liquid wealth are greater among childless households than households with children at all percentiles of the distribution. We find that liquid wealth constitutes 16% of total net worth for the median

[12]Non-housing financial wealth is defined to include the net value of stocks, mutual funds, and investment trusts; the value of checking, savings, or money market accounts; the value of CD, government savings bonds, and T-bills; the net value of bonds and bond funds; and the net value of all other savings; less the value of other debt. We use data from the final core interview because the exit interview data on the split between housing and non-housing wealth are less reliable.

childless household at ages 65-69 but only 8% for the median parent household. Consistent with this evidence, we find that homeownership rates at these ages are 81.3% among parents and just 72.5% among individuals without children. This evidence suggests greater precautionary savings needs of individuals without children, who must maintain a larger liquid buffer stock of wealth to smooth consumption.

As another explanation for the higher illiquid wealth holdings of parents, we propose that housing serves a special function within families as a commitment device to facilitate family informal care arrangements. Our housing-as-commitment-device hypothesis has three components. First, all else equal, homeowners should be more likely to receive informal care from children, and these arrangements will be more durable over time. Second, homeowners should dis-save their wealth more slowly than renters, in part to preserve bequests for their potentially caregiving children and in part because caregiving by children shields a parent's assets from spend-down on nursing homes. Third, children in caregiving families should receive larger bequests, and bequests of housing assets in particular. We now provide evidence consistent with these three predictions.

We first establish, in Table 2, that homeownership is predictive of receiving informal care.[13] The table reports coefficient estimates from linear probability models of receiving informal care in the current period, conditional on receiving some form of care. Coefficient estimates for two variables are reported: the inverse hyperbolic sine of wealth and the interaction of that measure with an indicator for homeownership, both taken from the previous interview. All models include controls for socio-economic characteristics and health status. The sample for the first two results columns includes all individuals receiving some form of care at the current interview. The remaining columns select subsamples of this group: individuals who did not receive care in the previous interview (third and fourth columns) or individuals who received informal care at the previous interview (fifth and sixth columns).

Across the columns, a consistent pattern emerges. When homeownership is not accounted for, prior wealth positively predicts receipt of informal care in most specifications. However, once we condition on prior homeownership, we observe that this positive association between wealth and informal care is only evident for homeowners, suggesting that it is housing wealth in particular rather than overall wealth that matters for informal care arrangements. This pattern holds for individuals newly entering care arrangements (third and fourth columns) and for individuals previously receiving informal care (fifth and sixth columns). The latter suggests that a parent's homeownership may increase the longevity of informal care arrangements. Together, this evidence hints that there is something about homeownership *per se* that is increasing the likelihood of receiving infor-

[13]Throughout this section, informal care is defined as receiving more than 50% of care hours from informal sources (family or other unpaid individuals) and receiving no nursing home care. For our sample of single elderly decedents, the vast majority of informal care is provided by adult children.

mal as opposed to formal care.

Table 2: Informal care arrangements and housing

	Prob IC at t | care at t		Prob IC at t | care at t *(cond. no care at t-1)*		Prob IC at t | care at t *(cond. IC at t-1)*	
	(1)	(2)	(3)	(4)	(5)	(6)
ihs(Wealth) (t-1)	0.0082***	0.00098	0.0075***	0.00053	-0.00052	-0.0049**
	(0.0012)	(0.0015)	(0.0022)	(0.0029)	(0.0018)	(0.0024)
Wealth x Own (t-1)		0.011***		0.0088***		0.0065***
		(0.0013)		(0.0022)		(0.0023)
N	6475	6385	1760	1726	1856	1836
Mean of Y	0.47	0.47	0.59	0.59	0.67	0.67

Standard errors clustered at the household level in parentheses. * p<.1, ** p<.05, *** p<.01. Core interviews 2002-2010 and exit interviews 2004-2012 for our sample of single decedents. The notation "t" refers to the current interview, and "t-1" refers to the previous interview. The table reports coefficient estimates from linear probability models. The outcome in all specifications is an indicator equal to 1 if the individual is in an informal care arrangement and 0 otherwise. Informal care is defined as not receiving nursing home care and receiving more than 50% of care hours from informal sources (family or other unpaid individuals). *Own* is an indicator for home ownership. *ihs(Wealth)* is the inverse hyperbolic sine transformation of net worth. *Wealth x Own* is the interaction of the two. Samples vary across the specifications. All samples are conditional on receiving some form of care (either informal home care, formal home care, or nursing home care) at the current interview. Columns (3)-(4) add the restriction that individuals did not receive any form of care at the prior interview. Columns (5)-(6) impose the restriction that individuals received informal care at the previous interview. In all specifications, controls include: age, sex, indicators for black or other non-white, an indicator for hispanic ethnicity, indicators for education levels (high school or GED, some college, college and beyond), an indicator for being coupled, numbers of ADL and IADL limitations, an indicator for ever having memory disease, and indicators for each interview wave.

Having shown that informal care arrangements are more prevalent and persistent among homeowners, we next establish that homeowners dis-save their wealth more slowly than non-owners. We already presented graphical evidence to this effect in Figure 3. Now, we demonstrate that this connection is robust to controlling for observable differences between owners and renters in socioeconomic characteristics and health status. We present this evidence in Table A2 in the Appendix, which reports results from quantile regressions for annualized wealth changes between core interviews (from the previous to the current interview). The table reports coefficient estimates for an indicator for homeownership at the previous interview.

Consistent with our hypothesis, we find estimates for the coefficient on homeownership to be positive and significant across specifications, indicating that homeownership is associated with slower rates of dis-saving (or higher rates of saving). The magnitudes of the coefficients are very large relative to the median annualized change in wealth, which is just -$86. The coefficient estimates change little with the inclusion of additional covariates, suggesting that the positive association between prior ownership and changes in wealth cannot be entirely explained by observable differences in demographics or health between owners and renters. Even conditional on care arrangement, we observe that homeowners dis-save more slowly than renters.

We present regression evidence on the third and final component of our hypothesis in Table 3. The dependent variables in the first two columns describe the overall estate: they include an indicator for whether a non-zero estate was left and the log of the estate value. The second pair of columns focuses on housing assets in particular. The dependent variable in the third results column is an indicator equal to 1 if the decedent owned a home at the time of death and 0 otherwise. The dependent variable in the final column is a broader measure that is also equal to 1 if the decedent made an inter-vivos transfer of housing assets to children prior to death. (See the table footnote for more details.)

Table 3: Bequests and informal care

	Overall Estate		Housing	
	Any Estate	Log Value	Bequest	Beq. or IVT
Avg wkly LTC hours	-0.0017***	-0.0034***	-0.0020***	-0.0018***
	(0.00023)	(0.0012)	(0.00022)	(0.00025)
Avg wkly child LTC hours	0.0011***	0.0053**	0.0015***	0.0020***
	(0.00039)	(0.0022)	(0.00038)	(0.00042)
Observations	3221	1855	3223	3223
Adjusted R^2	0.205	0.231	0.089	0.071
Mean of Y	0.63	11.5	0.36	0.48

Robust standard errors in parentheses. * p<.1, ** p<.05, *** p<.01. Under the heading *Overall Estate*, the dependent variables are *Any Estate*, an indicator equal to 1 if the decedent left a non-zero estate and 0 otherwise, and *Log Value*, the log of the estate value. Under the heading *Housing*, *Bequest* is an indicator equal to 1 if a decedent died owning a home and 0 otherwise. *Beq. or IVT* is equal to 1 if any of the following are true: a decedent (i) died owning home, (ii) disposed of a home prior to death by giving the home away, (iii) ever reported living in a home owned by her children which she had previously owned, (iv) ever gave a home deed to a child, or (v) ever gave a home to someone. If none of the above are true, the variable is equal to 0. *IVT* stands for "inter-vivos transfer." *Average wkly LTC hours* and *Average wkly child LTC hours* are the average number of weekly hours of care received in total and from the younger generation, respectively, during the sample period. These are calculated assuming that LTC hours reported at an interview are constant throughout the period described by that interview. We then cumulate hours from all interview periods and divide by the amount of time (in weeks) covered by the interviews. Other controls include: age at death, years of schooling, an indicator equal to 1 if the respondent was ever married or partnered in the observation period and 0 otherwise, an indicator for any children and the number of living children at the time of death, the (inverse hyperbolic sine of) mean household income across all available core interviews. Specifications also include indicators for each exit interview wave and a constant term. All models are estimated with ordinary least squares.

Coefficient estimates for two regressors of interest are reported in the rows. The first is average weekly hours of care from all sources during the sample period, which we regard as a summary measure of disability. The second is average weekly hours of care from children (also grandchildren, their spouses and partners, etc.), which measures receipt of informal care. The negative coefficient estimates in the first row suggest that more disabled individuals are less likely to leave bequests, both overall and for housing in particular, and/or to give housing assets as an inter-vivos transfer. On the other hand, the positive coefficient estimates in the second row indicate that, holding total hours of care constant, receiving more care from informal sources is associated with a higher probability of leaving or transferring assets to one's children. In fact, the positive association between bequests and informal care largely counteracts the negative association with poor health, consistent with the idea that informal care is protective of bequests. The overall message of the results is that children in caregiving families are more likely to receive bequests, to receive larger bequests conditional on receiving a bequest, and to inherit housing assets, either as a bequest or as an inter-vivos transfer just prior to death.

Additional evidence. In the Appendix, we present three additional pieces of evidence to strengthen the connections outlined above. First, in Tables A3 and A4, we show that the positive correlations between bequests and informal care from Table 3 are primarily driven by nursing home events, which are negatively associated with both informal care and bequests. Once we condition on an indicator of whether an individual ever lived in a nursing home, the correlations between informal care and bequests are no longer significantly different from zero.

These results suggest that informal care leads to larger bequests only insofar as it substitutes (even if imperfectly) for more costly nursing home care. We provide evidence of this substitution in Table A5, where we show that prior receipt of informal care is negatively associated with nursing home entry even after conditioning on health, wealth, and homeownership. In conjunction with our finding in Table 2 that homeowners are more likely to receive informal care, these results suggest that homeowners may dis-save more slowly and leave larger bequests in large part because they are more likely to substitute informal care for nursing home care than are otherwise similar individuals who rent.

Finally, we present evidence that the mechanism linking informal care and bequests is much stronger for owners than renters. Specifically, in Table A3, we show that the positive correlations between informal care and bequests disappear in a sub-sample of decedents who were never homeowners but persist (albeit with less significance) in a sample of owners.

Taken together, the evidence suggests a special role for housing. If parents could commit to future transfers to their children in exchange for informal care, we would not expect the relationship between informal care and bequests to hold only for owners and not for renters nor would we expect homeownership to be predictive of informal care receipt after conditioning on overall wealth. The fact that we observe these patterns in the data lends further support to our theory of housing as a commitment device.[14]

3 The Model

Based on our empirical findings, we construct a model that encompasses: (i) a housing choice, (ii) a caregiving choice, and (iii) strategic interactions between parents and children. We insert these ingredients into a standard overlapping-generations structure with incomplete markets and longevity risk.

[14] We thank Karen Kopecky for these suggestions.

3.1 Setup

Overview. Time is continuous. The economy is populated by overlapping generations of individuals; there is no population growth. An individual's age is denoted by j. Individuals work when $j \in [0, j_{ret})$, where j_{ret} is the retirement age; they are retired when $j \in [j_{ret}, j_{dth})$, where $j_{dth} = 2j_{ret}$ is the maximum life span. Markets to insure against risk are absent; there is a savings technology with exogenous return r, and agents face a no-borrowing constraint.

Family structure. A *family* is made up of two *households* (or *agents*): a *kid household* (or just *kid*, indexed by k) of age $j^k \in [0, j_{ret})$ and a *parent household* (or just *parent*, indexed by p) of age $j^p = j^k + j_{ret}$. There is a measure one of families for each kid age $j^k \in [0, j_{ret})$ in the economy.

State variables. We first establish some notation to facilitate the exposition. A family's state is given by the vector $z \equiv (a^k, a^p, s, \epsilon^k, \epsilon^p, h, j^p)$. $a^k \geq 0$ denotes the kid's wealth, $a^p \geq 0$ the parent's. ϵ^k and ϵ^p are productivity states from a set $E \equiv \{\epsilon_1, \ldots, \epsilon_{N_\epsilon}\}$. $s \in S \equiv \{0, 1, 2\}$ is the health state of the parent: $s = 0$ stands for *healthy*, $s = 1$ for *disabled*, and $s = 2$ for *dead*. Finally, $h \in H \equiv \{0, h_1, \ldots h_{N_h}\}$ denotes the value of the parent's house; $h = 0$ refers to renting, and the states h_1 to h_{N_h} are house sizes from a finite set. Children always rent.

Sources of uncertainty. We assume that children face uncertainty about their labor productivity but that parents do not. Specifically, ϵ^k follows a Poisson process with age-independent hazard matrix $\delta_\epsilon = [\delta_\epsilon(\epsilon_i, \epsilon_j)]$, where entry $\delta_\epsilon(\epsilon_i, \epsilon_j)$ gives the hazard rate of switching from state i to state j.[15] Once a household reaches age 65, it stays with the productivity state it has at that point in time and receives a pension flow that is a function of this state: $y_{ss}(\epsilon^p)$, where ss stands for Social Security. Before age j_{ret}, income is a function of productivity and age: $y(j^k, \epsilon^k)$. When a child enters retirement, it becomes a parent and is matched to a child household that is assumed to start life with the same productivity state that the parent has. Agents are healthy ($s = 0$) before retirement age. From age 65 on, the parent faces a hazard $\delta_s(j^p, \epsilon^p, s)$ of transitioning into the disabled state.[16] Once $s = 1$, the parent cannot return to the healthy state again. In both health states, the parent faces a mortality hazard $\delta_d(j^p, \epsilon^p, s)$. When the parent dies, the parent's net worth, $a^p + h$, including both financial and housing assets, is transferred to the child. There is no estate tax.[17] Agents do not face a death hazard before retirement.

[15] We define the diagonal elements of a (generic) hazard matrix δ as $\delta_{ii} = -\sum_{j \neq i} \delta_{ij}$, so that all rows of δ sum up to zero.

[16] We allow this hazard to depend on ϵ^j to capture that the disability hazards vary substantially across socioeconomic strata. We define $\delta_s(\cdot, s > 0) = 0$ for non-healthy states for notational convenience.

[17] This is realistic for our purposes since only the richest 0.2% of households pay estate taxes under current U.S. rules; see, Joint Committee on Taxation (2015).

Out-of-pocket medical expenditures are known to be a severe financial risk that drives the savings decisions of the elderly in the U.S; we thus include this feature in our model. In retirement age, the parent suffers a *medical event* with hazard $\delta_m(j^p, \epsilon^p, s)$. Upon such an event occurring, the parent draws a lump-sum cost M from a cdf $F_M(M)$.

Consumption, savings, and gift-giving. Households face a standard consumption-savings trade-off at each point in time, with the additional possibility of gifts. In each instant, both agents choose a non-negative gift flow, $\{g^i\}_{i\in\{k,p\}}$, to the other agent. They also decide on a consumption flow, $\{c^i\}_{i\in\{k,p\}} \geq 0$. Savings are then residually determined from the budget constraint.

Housing. Children are always renters.[18] Once the child enters retirement and becomes a parent, it can buy a house; the feasible set of houses for a kid with assets a^k is $\{h \in H : h \leq a^k\}$, due to the no-borrowing constraint. At each moment in time, i.e. for all $j \geq j_{ret}$, the parent can then decide to sell the house at price h. We denote this decision by $x \in \{0, 1\}$, where $x = 1$ stands for selling. Houses cannot be bought after age j_{ret}, only sold. Renters can freely choose the size of their apartment at each point in time. We assume that homeowners derive an extra-utility benefit from owning. Formally, we assume that housing services, $\tilde{h} \in \tilde{H}(h)$, consumed by a household with housing state h are chosen from

$$\tilde{H}(h) = \begin{cases} [0, \infty) & \text{if } h = 0 \text{ (renter)}, \\ \{\omega h\} & \text{if } h > 0 \text{ (owner)}, \end{cases}$$

where $\omega \geq 1$ is a parameter that governs the premium on owning. Flow expenditures for housing are given by the function

$$E_h(h, \tilde{h}) = \begin{cases} (r + \delta)\tilde{h} & \text{if } h = 0 \text{ (renter)}, \\ \delta h & \text{otherwise (owner)}, \end{cases}$$

where $\delta > 0$ is the depreciation rate of housing and r is the interest rate. Renters have to pay the rental rate that would obtain in a perfectly competitive rental market, $r + \delta$, for the housing services $\tilde{h}$ they buy on the rental market. Owners only have to pay for repairs to their house that keep depreciation at bay.

Long-term care. We first describe the different care technologies that are available to the family; the family's decision-making process is then explained in the paragraph titled "Bargaining options" below. A disabled parent ($s = 1$) must cover her care needs from one of the following sources:

[18] We make this assumption to keep the size of the state space manageable.

1. *informal care* (IC, $i = 1$): The child gives care to her parent. There are no direct costs from this, but the kid household gives up a fraction β of labor income, capturing the opportunity cost of time on the labor market.

2. *formal care* (FC, $i = 0$): If the family decides against IC, the parent has to obtain *formal care* from one of the following sources:

   (a) *Medicaid* (MA, $m = 1$): When choosing Medicaid, the parent lives as a renter in a government-sponsored nursing home and receives a fixed consumption level, C_{ma}.[19] Medicaid is means-tested; we describe this means test in detail in the paragraph labeled "Timing protocol" below.

   (b) *privately-paid care* (PP, $m = 0$): Alternatively, the parent can buy care services on the private market. Depending on whether the parent owns a home or rents, this takes the form of:

      i. *nursing home care* (NH): If the parent does not own a home ($h = 0$), she enters a nursing home. In NH, the parent has to buy *basic care services* at the price p_{bc} and decides on other consumption expenditures, c^p. Following Kopecky & Koreshkova (2014), we interpret $p_{bc} + c^p$ as nursing home expenditures, where the component c^p captures room and board and the amenities of the facility.

      ii. *formal home care* (FHC): Home owners ($h > 0$) stay at home and buy formal-home-care services at the price p_{fhc}. Additionally, the parent pays for housing depreciation and chooses consumption expenditures, c^p.

Preferences. *Flow felicity* of household $i \in \{k, p\}$ with consumption c^i and enjoying housing services $\tilde{h}^i$ is given by:

$$u(c^i, \tilde{h}^i; n^i) = \frac{n^i}{1-\gamma}\Big(\tfrac{1}{\phi(n^i)} \underbrace{(c^i)^{\xi}(\tilde{h}^i)^{1-\xi}}_{c\text{-}h\text{-aggregate}}\Big)^{1-\gamma}. \tag{1}$$

Here, $\xi \in (0, 1)$ is the consumption share in the Cobb-Douglas aggregator over housing and other consumption. $\gamma > 0$ is a parameter that governs how strongly households want to smooth the consumption aggregate over time and across states of the world. $n^i = n(j^i, s)$ is the number of household members, which is a deterministic function of age and the disability state.[20] $\phi(n)$ is a household equivalent scale that satisfies $\phi(1) = 1$ and $\phi'(n) \in [0, 1]$ for all $n \geq 1$. *Flow utility*

[19] This consumption floor includes any negative utility from MA, such as stigma effects and poorer quality of care. We assume that MA recipients are renters, thus C_{ma} is in terms of the consumption-housing aggregate; see the paragraph labeled "Preferences" below.

[20] We introduce this feature to generate more realistic consumption profiles over the life cycle.

of household i in an instant is given by $U^i = u^i + \alpha^i u^{-i}$, where $-i$ denotes the other household in the family and where $\alpha^i > 0$ is agent i's, $i \in \{k, p\}$, altruism parameter. Both households discount expected utility at the rate $\rho > 0$. Once dead, the parent values the kid's felicity at α^p, the grandchild's felicity at $(\alpha^p)^2$, and so forth; this gives rise to a recursive representation for value functions as is standard in the altruism literature.

Bargaining options. We assume that in each instant, the parent and kid bargain over two choices: the informal care provision and the house-selling decision. Formally, we assume that a state z is associated with the following set of bargaining options (which we will also refer to as *inside options*) that the two agents can implement instead of the outside option. Define this set as

$$\mathcal{I}(z) = \begin{cases} \{\} & \text{if } s = 0 \text{ and } h = 0, \\ \{\text{keep}\} & \text{if } s = 0 \text{ and } h > 0, \\ \{\text{IC}\} & \text{if } s = 1 \text{ and } h = 0, \\ \{\text{keep+IC}, \text{sell+IC}\} & \text{if } s = 1 \text{ and } h > 0. \end{cases}$$

We are assuming that: (i) for healthy renters, there is nothing to bargain on; (ii) healthy homeowners only bargain on the house-selling decision;[21] (iii) disabled renters only bargain on informal care provision; and (iv) disabled homeowners bargain jointly on informal care and house-selling. Note that the parent has the option to keep the house and buy FHC services under the outside option (and the kid may help the parent to do so by giving gifts), but we do not need to specify this.

When agreeing on an inside option $i \in \mathcal{I}(z)$, agent's can make a side payment—or *exchange-motivated transfer*—Q, in the form of a monetary flow. We denote Q as a net flow from parent to child: i.e., the transfer goes from parent to child when $Q > 0$ and from child to parent when $Q < 0$. There is also the *outside option* (denoted by *out*). Under this option, the parent decides unilaterally on the source of formal care (when disabled) and whether or not to sell the house (if an owner), and bargaining transfers are zero ($Q = 0$). We denote the set of all options by $\mathcal{B}(z) \equiv \{\mathcal{I}(z), out\}$.

Note that under both the inside and outside options, the state z may change if the house is sold. We define the new state associated with option $b \in \mathcal{B}(z)$ as

$$z'(z, b) = \begin{cases} (a^k, a^p + h, s, \epsilon^k, \epsilon^p, 0) & \text{if house sold under } b. \\ z & \text{otherwise.} \end{cases}$$

Furthermore, we impose the following lower and upper bounds for the transfer Q under inside

[21] We include bargaining for the healthy for two reasons. First, symmetry to the other cases. Second, we find that this helps to maintain value functions smoothness in our algorithm; if the parent sells the house and this is not desired by the child, this introduces large discontinuities in the kid's value function that are difficult to deal with computationally.

option $b \in \mathcal{I}(z)$:

$$\bar{Q}_l(z,b) = \begin{cases} 0 & \text{if } b \text{ specifies IC and that the parent rents,} \\ -\bar{T}_k(z) & \text{otherwise.} \end{cases},$$

$$\bar{Q}_u(z,b) = \begin{cases} 0 & \text{if } s = 0 \text{ and } h > 0, \\ \bar{T}_p(z) & \text{otherwise.} \end{cases},$$

where $\bar{T}_p(z)$ and $\bar{T}_k(z)$ are (large) exogenous bounds on transfers that we set as a multiple of the receiving agents' incomes in the computations.[22] That is, we assume that: (i) when IC is given to a renting parent, an exchange-motivated transfer can only flow from parent to child (since the kid provides a service for the parent); (ii) when the parent is a healthy homeowner, the transfer can only be from child to parent (since the parent is doing a favor to the child by refraining from selling); and (iii) when a parent keeps the house and receives IC, we impose no bound on Q (since both parties potentially benefit from the arrangement).

Bargaining protocol. We assume that bargaining power is entirely with one of the two agents, depending on the situation or state z; this considerably speeds up the computation of the equilibrium. Specifically, we assume that the powerful agent makes a take-it-or-leave-it offer to the other agent; i.e., the powerful party proposes a combination of an inside option $i \in \mathcal{I}(z)$ and a transfer $Q \in [\bar{Q}_l(z,i), \bar{Q}_u(z,i)]$. The weak party then either accepts or rejects. If the bargain is rejected, (i) disabled parents have to obtain care from formal sources, and (ii) owning parents have the option to sell the house unilaterally after the bargaining stage (see the timing below).

Bargaining power. We assign bargaining power as follows. (i) If the parent is disabled and rents, the parent has all bargaining power. This choice is motivated by the fact that Barczyk & Kredler (2018) estimate the child's bargaining weight in an IC decision in a similar setting to be close to zero. (ii) For the case of healthy home-owning parents, we assign all bargaining power to the child. Assigning the power to the parent would seem unreasonable, since this would enable the parent to extract the maximal transfer from the child in exchange for not selling the house. (iii) Finally, for disabled home-owning parents, we assume that the bargaining power sits with the child if and only if the parent would sell the house under the outside option, in line with scenarios (i) and (ii).

[22] These bounds can become binding when one agent wants to give large gifts to an agent inside the state space; see also the appendix on optimal gift-giving, E.1. When an agent is broke, the bound on transfers is given by the agent's flow income.

Timing protocol. The sequence of decisions over an infinitesimal amount of time, $[t, t + \mathrm{d}t)$, unfolds as follows over the following five *stages*:

1. *bargaining*: The party with bargaining power makes an offer (i, Q), where $i \in \mathcal{I}(z)$ and $Q \in [\bar{Q}_l(z,i), Q_u(z,i)]$.[23] The weak party then either accepts or rejects.

2. *house-selling*: If bargaining was not successful (i.e., the weak party rejected in Stage 1), owning parents decide whether to sell their house or not, $x \in \{0, 1\}$.

3. *gift-giving*: Parent and child choose gift flows, $g^p, g^k \geq 0$,

4. *Medicaid*: Disabled parents in formal care decide whether to receive MA or not, $m \in \{0, 1\}$. Parents in MA have to hand over all income, assets, and any transfers received in Stages 1 or 3 to the government. However, they are allowed to keep their home.[24]

5. *consumption*: Parent and child choose consumption flows, $c^p, c^k \geq 0$. Renters choose housing services.

After all decisions are made, utility is collected, interest on saving accrues, and shocks (to income, health, and medical expenditures) realize.

Production technologies and government. In one of our counterfactuals (*Sweden*), we will consider generous government provision of formal-care services. For this counterfactual to be credible, we increase Social Security contributions in order for the government to be able to finance this policy. To implement this in our model, we have to take a stand on the production technology for care and on the government's budget constraint. We specify linear technologies in labor for care services and a government budget constraint; see Appendix B.1.

3.2 Equilibrium definition

We adopt a standard stationary equilibrium definition and restrict attention to Markov-perfect equilibria. Both agents respond optimally to each other in each stage and in each instant of the game. Restricting ourselves to Markovian strategies allows us to use Hamiltonian-Jacobi-Bellman (HJB) equations to characterize the solution to the game. We then consider the ergodic measure of families that results from these conditions to calculate aggregate variables.

[23] Note here that by backward induction, the house-selling decision in Stage 2 can be determined independently of the bargaining outcome in Stage 1. Thus, bargaining power can be assigned without problems in families with disabled home-owning parents.

[24] In the equilibrium, MA individuals do not own a home. Individuals choose to sell their home before making use of MA since MA provides an undesirable consumption floor.

3.3 Solving for equilibrium

Appendix B derives the HJBs for both players by backward induction over the stages of the instantaneous game. We then derive results that characterize each player's best responses and substantially simplify the solution of the model, which makes solving the model numerically feasible. We solve for the equilibrium value functions by backward iteration on age, j^p, using standard Markov-chain approximation methods.[25] We backward-iterate over multiple generations until the value functions of children at j_{ret} converge. Given the equilibrium policies resulting from these value functions, we then solve for the stationary density of families over the state space by forward-iterating on the Kolmogorov Forward Equation. Appendix E contains the details.

3.4 Equilibrium dynamics

We now briefly describe the dynamics generated by our model. While the parent is healthy, both parent and child engage in standard precautionary-savings behavior. When one of them undergoes a long spell of bad earnings realizations, this household may receive altruistically-motivated gifts from the other.

However, healthy parents only run down their asset stock at a slow pace in retirement. They maintain a buffer stock of savings for both precautionary reasons (LTC and medical-spending shocks) and to leave a bequest. Once the disability shock or a large medical-expenditure shock hits, the parent may receive transfers from the child in terms of money or time (informal care) or opt for government-provided Medicaid care.

Figure 4 illustrates typical equilibrium outcomes for disabled parents, juxtaposing renters and homeowners (left-hand-side vs. right-hand-side graphs) and high- and low-wage kids (top vs. bottom graphs). The figures show, for different levels of parent and child wealth, which care arrangement occurs (indicated by the shading of the areas) and what the wealth dynamics are (the phase arrows). We see that when the child has a high opportunity cost of caregiving, she never gives informal care to the parent. This makes the parent spend down her wealth on formal care; which occurs in the form of formal home care for home owners and in the form of nursing homes for renters. In the top-right graph, we see that the owning parent sells her house once she has run out of liquid assets; she then jumps to the upper-left graph and enters a privately-paid nursing home until her assets are spent altogether, at which point she enters a Medicaid nursing home (the black area).

We now move to the two bottom graphs of Figure 4, which depict families in an identical

[25]The Markov-chain approximation method we use is equivalent to a classical finite-difference method of the explicit type. For a friendly user guide, see `https://qeconomics.org/ojs/index.php/qe/article/view/163` and click on View (Supplement).

Figure 4: Equilibrium dynamics

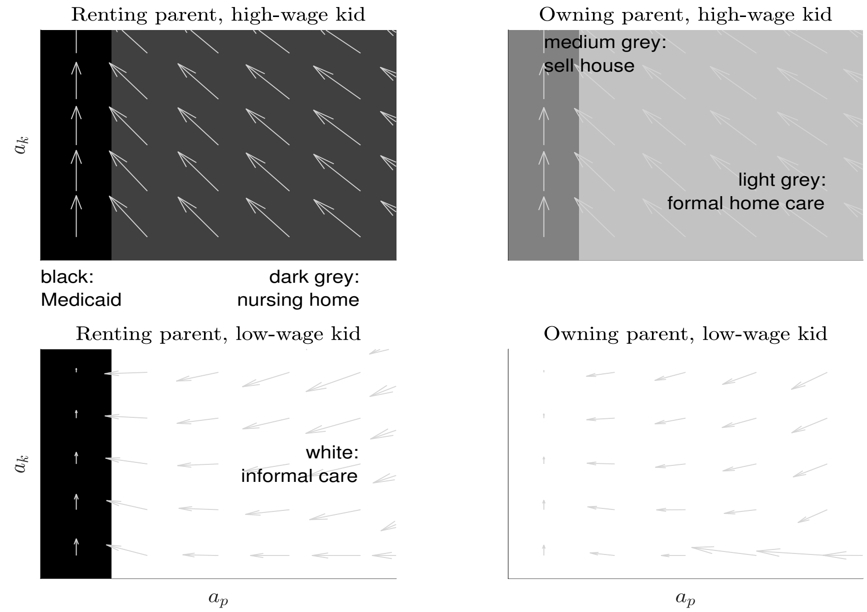


Figure shows equilibrium dynamics in baseline calibration at age $t^p = 90$ for disabled parents. The “owning parent” owns a house worth 100K. “High-wage” / “low-wage” kid refer to productivity grid points 2 and 3 of ϵ^k. In all graphs, parents have the lowest productivity realizations. Arrows depict phase vector $[\dot{a}^k, \dot{a}^p]$ in equilibrium. The asset axes (a^p, a^k) go from 0 to 300K$.

situation to the top row, but with a low-wage child. Since the kid’s opportunity cost is lower, informal care is now predominant, as the white areas indicate. In the IC areas of both bottom graphs, the parent gives an exchange-motivated transfer to the child (not shown). We note that the parent spends down her wealth slower when owning than when renting, which occurs because owning provides extra utility and because an owning parent can arrange lower transfers in exchange for IC than a renting parent, due to the promise of a higher bequest.

Finally, comparing the wealth dynamics at the vertical axes of the bottom graphs reveals a key mechanisms of the model: owning a house guarantees IC to a parent of a low-wage child. We see that even when all financial assets are run down, the home-owning parent still receives IC and does not sell the house. The phase arrows show that this situation is stable; as long as the child does not receive a positive income shock, the family maintains this arrangement. In the lower-left graph, however, we see that IC can only be maintained for some time when the parent has financial wealth but is a renter. In this case, the parent spends down her financial wealth and enters Medicaid once she is broke. What is the mechanism behind this difference? The key here is that the illiquidity of the house gives the parent the power to commit to a low consumption profile. An owning parent without financial assets cannot consume more than her income flow (minus transfers to the kid) whereas renting parents with financial wealth succumb to the temptation of spending down their wealth faster. The kid knows this and demands higher transfers in return for IC, which makes parent wealth be depleted even sooner for renters. For owning parents, however, the housing asset is maintained indefinitely and serves as a guarantee to the child to receive a sizable bequest and thus motivates her to give care even at low immediate transfers.

In passing, we note that Figure 4 provides an early indication that the model is capable of reproducing several key features of the data presented in Section 2: namely, that owners dis-save more slowly, are more likely to receive informal care, and spend more time in such arrangements than renters.

4 Calibration

We calibrate our model to the US economy in the year 2010. Table 4 gives an overview of parameters and calibration targets, which we now briefly discuss. In general, note that we tie our hands by fixing most parameters by either directly estimating them from the data or by taking them from other studies, leaving the model with a low number of degrees of freedom; we pin these down by matching five moments that are related (close to) one-for-one with the remaining parameters.

Demography. We set the length of a life phase to $j_{ret} = 30$ years. The start of an agent's life correspond to age 35 in the data and retirement to age 65; parents die with certainty at age 95. As for household size n_i, we assume that each kid household is composed of two members. After retirement, we let the number of members in healthy parent households decrease smoothly from 2 to 1 in a way that is consistent with the observed survival of males in the HRS. Once the parent is hit by the disability shock, household size is assumed to be 1 (widowhood).

Housing. The grid for housing is $h \in \{50, 100, 200, 400\}$, expressed in thousands of dollars.[26] Following Nakajima & Telyukova (2018), we set housing depreciation to $\delta = 1.7\%$ and the consumption share in utility to $\xi = 0.81$.

Shocks. We follow Barczyk & Kredler (2018) in order to estimate labor-productivity, LTC and mortality risks, and the process for out-of-pocket medical expenditures (net of LTC expenditure), where we update the data in order to account for the fact that our economy is calibrated to the year 2010 (and not to 2000). A brief description is as follows. Efficiency units of labor are estimated using a Mincer regression with a cubic polynomial using US Census data for the year 2010. Disability and mortality hazards are estimated in logistic regressions using HRS data; we define disability as requiring 90 or more hours of care per month. The out-of-pocket medical-expenditure distribution is assumed to be log-normal; we estimate it using both core and exit

[26]We experimented with various housing grids, including finer ones and including grids with larger maximal housing sizes. We found that the results along a variety of dimensions do not change much. Specifically, given our earnings process, only a small fraction of agents in the economy are willing to buy large houses.

Table 4: Calibration

γ	ξ	δ	r	ρ^{ϵ}	β	ψ	p_{fhc}	p_{bc}	MA	A_y	A_f
2	0.81	1.7%	2%	0.95	2/3	54.8%	\$38.4	\$35.3	\$64.4	1	$(35.3)^{-1}$

Parameters calibrated outside of model. Dollar figures in \$000's of 2010 dollars.

Age-earnings profile	LTC hazard	Mortality hazard	Medical costs
US Census: 2010	HRS: 2000-2010	HRS: 2000-2010	HRS: 2006-2010

Own estimates from HRS and US Census data.

Calibration target	Data	Model
Median household wealth (ages 65-69)	\$203.0	\$203.2
Home-ownership rate (ages 65+)	74.1%	74.6%
Medicaid uptake rate	29.6%	29.8%
Mean (annual) gift: (healthy)-parent-to-child	\$2.27	\$2.23
Mean (annual) gift: child-to-(FC)-parent	\$1.02	\$1.02
Parameter	**Description**	**Value**
ρ	Discount rate	0.0725
ω	home-ownership premium	2.000
C_{ma}	Medicaid consumption floor	\$4.75
α^p	Parent altruism	0.4458
α^k	Kid altruism	0.0258

Model-calibrated parameters. Data source: HRS core interviews waves 1998-2010. Samples includes all HRS respondents surveyed during this period. Dollar figures in \$000's of 2010 dollars. Home ownership rate is the average homeownership rate among those aged 65 and above. Medicaid uptake rate is fraction among single, disabled elderly ages 65+ who obtain Medicaid-financed care at home or in a nursing home. Mean gift parent-to-child is average annual financial transfer from healthy parent(s) aged 65+ to all children (including zeros). Mean gift child-to-parent is average annual financial transfer from children to disabled parents receiving privately-financed formal care at home or in a nursing home (including zeros).

interviews from the HRS.

Care technologies. As for the production sector, we follow Barczyk & Kredler (2018). We normalize productivity in the consumption-goods sector to $A_y = 1$. We follow Barczyk & Kredler (2018) in assuming that a kid household loses one third of labor income when providing informal care. The Medicaid consumption floor, C_{ma}, is calibrated in order for the model to match the fraction of disabled individuals that rely on Medicaid financing.

To pin down productivity in the nursing-home sector, we take from the data that the annual (average) Medicaid reimbursement rate in 2010 was $MA = 64,400\$$, based on Stewart et al. (2009). Recall that we defined the price of basic care services, p_{bc}, to mean the cost of care that is absolutely essential (thus not including room and board and other amenities), which can plausibly considered to be an expenditure shock as opposed to a consumption choice. Based on several balance sheets of nursing homes across the U.S., we find that $\psi = 54.8\%$ of nursing homes' total costs are care-related.[27] Under the assumption that Medicaid provides for the bare minimum of care services, we back out that $p_{bc} = \psi MA = 38,400$, from which we then recover $A_f = [p_{bc}]^{-1}$.

In contrast to Barczyk & Kredler (2018), our model also includes formal home care. In order to get an estimate of the annual cost of formal home care, we ask how much it would cost for a disabled single person to receive exclusively formal home care. A disabled single individual living in the community in our sample receives a median of 210 hours of care monthly. We then multiply by the average hourly private-pay rate of a home caregiver in 2010 as reported by the Bureau of Labor Statistics and MetLife (2012) to obtain the annual cost estimate reported in Table 4.

Preferences. We set the coefficient of relative risk aversion to $\gamma = 2$, a standard value in the macroeconomics literature. The rate of time preference, ρ, is obtained by matching median household wealth at ages 65-69, ensuring that the wealth level at the beginning of retirement is reasonable. Parent altruism, α^p, is calibrated to match the mean annual transfer from non-disabled parents to children; we restrict to healthy parents here in order to exclude exchange-motivated transfers. Similarly, to plausibly calibrate child altruism, we rely only on those transfers in the HRS which flow from children to disabled parents receiving formal care, since most of these transfers flow for purely altruistic reasons in the model.[28]

5 Model validation

We now evaluate the fit of the model along dimensions that have not directly been targeted by the calibration and show that the model is successful in replicating the features of old-age economic behavior that we had uncovered in the data.

5.1 Savings behavior: Financial and housing wealth

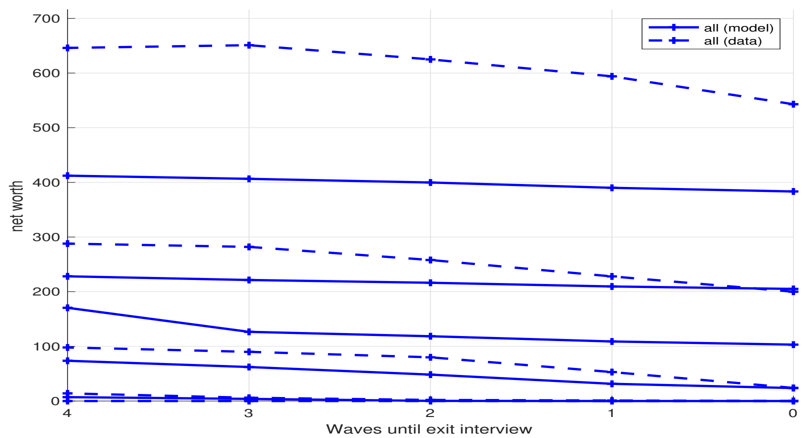
To evaluate the savings behavior of households, we use our model to draw an artificial panel in line with the construction of the HRS. We then construct wealth trajectories for households at the last four core interviews and the exit interview, a period that roughly corresponds to the final ten years of life.

Figure 5 compares the wealth trajectories between model and data for the entire sample, showing the 10th, 25th, 50th, 75th and 90th percentiles of the net worth distribution over time. First and foremost, we note that the model successfully matches the slow dis-savings behavior present

[27] We categorize the cost components of nursing home balance sheets into three categories—clearly-care-related, clearly unrelated to care, and unclear—and use the first and second categories to obtain an estimate of the fraction of costs that is care related. We then assume that the unclear category follows the same split.

[28] Average transfers include zeros in both cases in order to take into account both the intensive and extensive margins of gift-giving.

Figure 5: Net-worth trajectories



For both model and data, the five lines correspond to the percentiles 10/25/50/75/90 of the net worth distribution in a balanced panel. "Net worth" is financial plus housing wealth in $000 of year-2010 dollars. Data source: HRS core interviews 1998-2010 and exit interviews 2004-2012. Data are from a sample of single decedents appearing in the 2004-2012 exit interviews. Model: Artificial panel. Horizontal axis: Counts down interviews from the fourth core interview prior to death ("4") until the exit interview ("0"). Spacing between core interviews (i.e. 4 to 1) is two years, span between last core interview and exit interview (0) is shorter: on average about 1.5 years. None of these numbers are targeted in calibration.

in the data, manifesting itself in the only slightly negative slope of the lines. Second, we observe that the model successfully captures the fact that the lower part of the wealth distribution holds very little wealth—a feature of the wealth distribution that is often a challenge for incomplete-markets models. Key here is that the model successfully matches the fact that the poorer half of the population already enters retirement with only modest assets, see Table 5. Poor households in the model hold low wealth despite the large risks in retirement for two reasons: (i) the existence of family insurance through informal care and monetary transfers and (ii) the Medicaid consumption floor, which is taken up predominantly by poorer households. A shortcoming of the model is that it generates fewer wealthy households than is the case in the data.

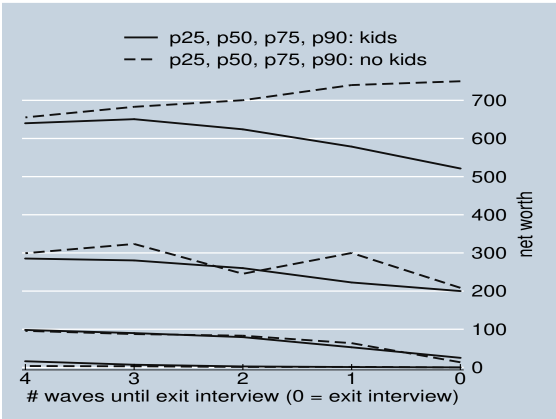
Table 5: Net-worth distribution entering retirement (ages 65-69)

Source	p10	p25	p50	p75	p90
Data	2	52	203	557	1200
Model	15	86	203	435	712

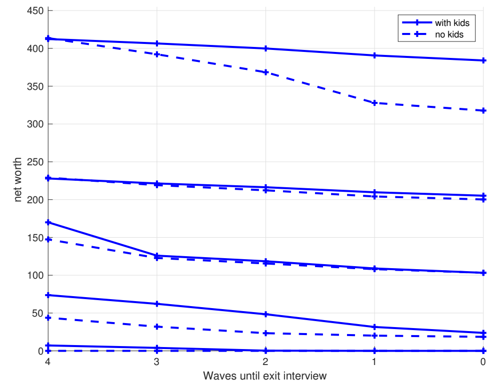
Percentiles of net worth distribution of age group 65 to 69 in $000s of year-2010 dollar. Data source: HRS core interviews, waves 1998-2010. Sample includes all HRS respondents surveyed during this period. For couples, the age of the eldest member of the household is used. Calculations use respondent-level weights. Only p50 is targeted in our calibration.

Furthermore, we find that the model is successful in replicating the savings behavior of the various sub-populations that we examined in our empirical work in Section 2. Figure 6 compares the net worth trajectories in the model to the data for three splits of the sample.

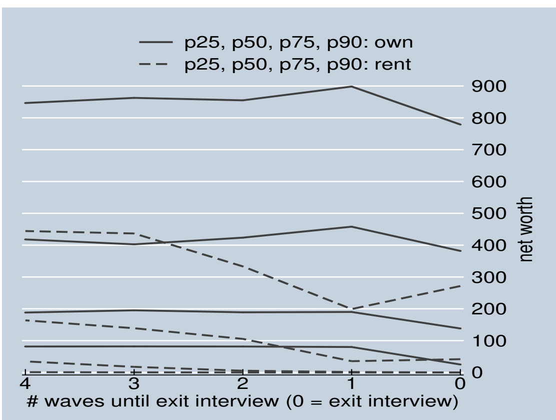
Figure 6: Net-worth trajectories for sub-groups



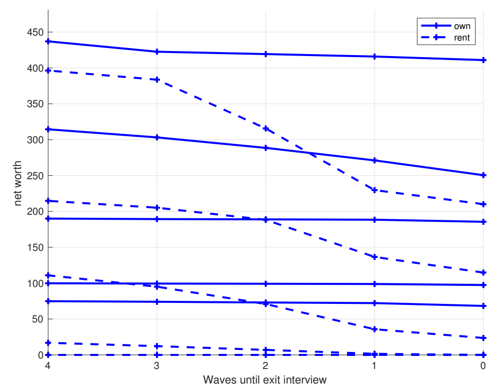
(a) Data: Parents vs. Childless



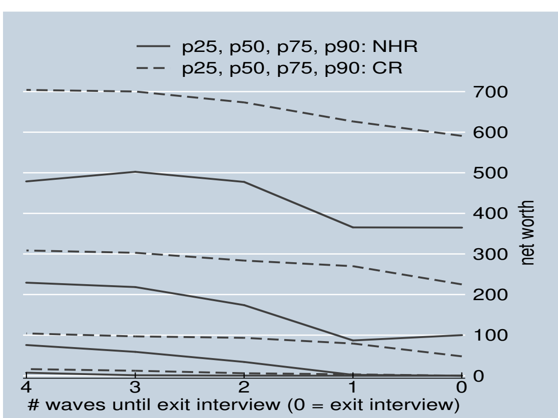
(b) Model: Parents vs. Childless



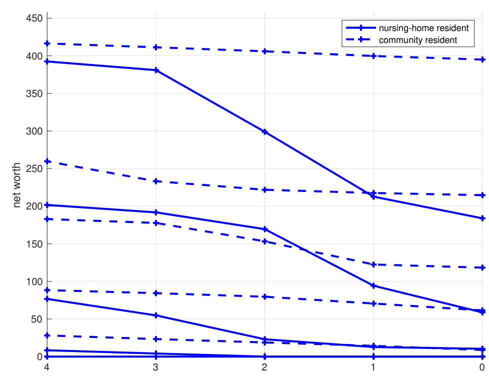
(c) Data: Own vs. Rent



(d) Model: Own vs. Rent



(e) Data: NH vs. Community



(f) Model: NH vs. Community

Figures on the left: HRS core interviews 1998-2010 and exit interviews 2004-2012. Sample of single decedents. Figures on the right: artificial panel generated from the model. Wealth percentiles 10, 25, 50, 75 and 90 recorded at 4, 3, 2, and 1 interview-waves prior to the exit interview and at the exit interview (= 0). Nursing home status and owning/renting is recorded at the time of the last core interview. None of the statistics targeted in calibration.

In the first row of the figure, we compare wealth trajectories by parenthood status. To obtain the trajectories for childless individuals in the model, we solve our model for a cohort of households that has no children but is otherwise identical to the baseline economy.[29] Along the 10th, 25th, 50th and 75th percentiles, the model produces very similar profiles for both the benchmark and the childless economy, a finding which is also apparent in the data. At the 90th percentile, however, the model predicts faster dis-saving by the childless, whereas in the data the reverse is true; however, one has to bear in mind that our sample of childless decedents is small. We will analyze the comparison between parents and childless households in greater depth in Section 6.

In the second row of Fig. 6, we split the sample by whether a household is a home owner in the last core interview (1 wave until the exit interview). We see that, in both model and data, owners are wealthier than renters; however, the model cannot generate enough wealth in the highest percentiles for owners (note that the scales in the two plots differ). The model is very successful when it comes to predicting dis-savings. Wealth trajectories for owners are essentially flat in both model and data. Renters, on the other hand, approximately reduce their net worth by one half over the last ten years in both model and data. We have to bear in mind, though, that we have conditioned on ownership in the final interview, so the renter trajectories also contain individuals who have liquidated their home before the final core interview, typically upon entry into a nursing home—an aspect we now turn to.

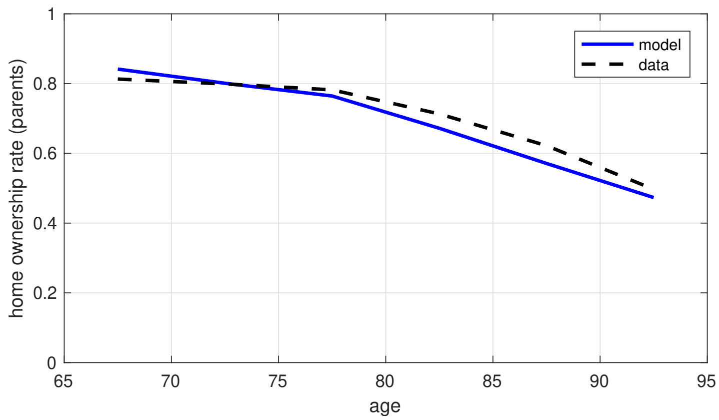
In the last row, we compare individuals who at the final interview prior to the exit interview were either residing in a nursing home or in the community. In both the data and the model, NH residents are substantially poorer than community residents. The model also predicts, as the data suggests, that nursing home residents experience a sharp decline in net worth (between the final two core interviews), which reflects the costly nature of LTC in a nursing home.

Finally, the model is also successful in predicting the liquidation of housing wealth over time. Figure 7 compares the model-implied ownership rate by age to its empirical counterpart (computed in a cross section).[30]

[29]Specifically, we assume that childless agents have no access to informal care and are not altruistic towards any other agent in the economy (thus bequests are "wasted"). In the data, we find that household income is distributed very similarly across the two groups. However, there are some statistically meaningful differences (in means): childless decedents are more likely to be male, uncoupled (both ever and at the last core interview), more educated (specifically, more college degrees and fewer with less than a HS degree/GED), more experienced, and slightly healthier (fewer functional limitations, less memory disease).

[30] The model slightly overshoots the ownership rate at age 65 and under-predicts the ownership rate at age 95. The latter is partly due to the fact that the maximum age an individual in the model can live to is age 95, which induces many model owners to liquidate in the years before reaching 95 but which is obviously unrealistic.

Figure 7: Homeownership in retirement



Cross-sectional home ownership-rate by age. 5-year age bins: $[65-70)$, $[70-75)$ etc. Data source: All HRS core interviews (1998-2010), both single and coupled households; "age" is age of eldest household person. Only average home-ownership rate above 65 targeted in calibration.

5.2 LTC arrangements

Our calibration only targeted the fraction of MA recipients. Nonetheless, Table 6 shows that the model obtains a good fit for the other care arrangements. The fraction of private payers in NH is also almost spot on. Crucially, the model does a very good job of generating a fairly high IC rate, in line with our data.[31] Our model slightly overshoots when it comes to IC prevalence. This may be due to additional costs of IC that exist in reality; an obvious candidate is a utility cost to the caregiving child, who may feel psychologically burdened when giving care to the parent. Finally, the model generates less FHC than we measure in the data; this may be due to the availability of cheaper sources of FHC than in our calibration (undocumented workers) or to a specific preference of the elderly for this form of care.

5.3 Inter-generational transfers: Bequests and inter-vivos

In our data, most transfers are delayed and given as bequests. Table 7 shows that IVTs are about one-fourth the size of bequests. The model successfully predicts this feature of the data but overstates IVTs relative to bequests somewhat. Barczyk & Kredler (2018) argue that in the data exchange-motivated transfers mainly occur in the form of co-residency, which is not included in the data measure for IVTs here. Our model is also in line with widely-cited numbers from Gale and Scholz (1994) on aggregate transfer statistics. Furthermore, the model is also very successful

[31] In contrast to Barczyk and Kredler (2018), who directly target this fraction by calibrating a utility penalty for formal care, we obtain this close match without an explicit preference for or against IC. In fact, the owning premium naturally encodes a reason why individuals may prefer IC: namely, it allows them to stay in their own home. In general, LTC choices in the model play out in a way that is similar to Barczyk and Kredler (2018), and we refer the reader to that paper for a more detailed discussion of the model fit in various care-related dimensions.

Table 6: LTC arrangements (in %)

Source	IC	FHC	NH	MA
Data	45.1	7.8	17.5	29.6
Model	51.2	2.5	16.5	29.8

IC: informal care, FHC: formal care at home, NH: privately-paid nursing home, MA: Medicaid-financed formal care. Data source: HRS core interviews waves 2002 to 2010. Disabled, single respondents ages 65+. The IC rate is calculated directly from data. IC is defined as receiving more than 50% of care hours from informal sources and receiving no nursing home care. We obtain the other rates as follows. In our sample, 15.0% obtain mostly formal care at home (<50% IC and no nursing home care), and 39.9% reside in a nursing home. BK2018 report that 47.9% of disabled FHC individuals are MA-financed. Among nursing home residents, Barczyk & Kredler (2018) report that 56.1% are fully or mostly covered by MA. We thus compute the FHC rate as $0.15 \times (1 - 0.479)$, the NH rate as $0.399 \times (1 - 0.561)$, and the MA rate as $0.15 \times 0.479 + 0.399 \times 0.561$. Only the MA rate is targeted in the calibration.

in generating the average ages at which a typical transfer dollar is given. This similarity is somewhat less surprising for bequests, since we fed estimated group-specific mortality hazards into our model, but for IVTs it is a bona-fide indication that the model does well in generating a realistic timing of transfers.

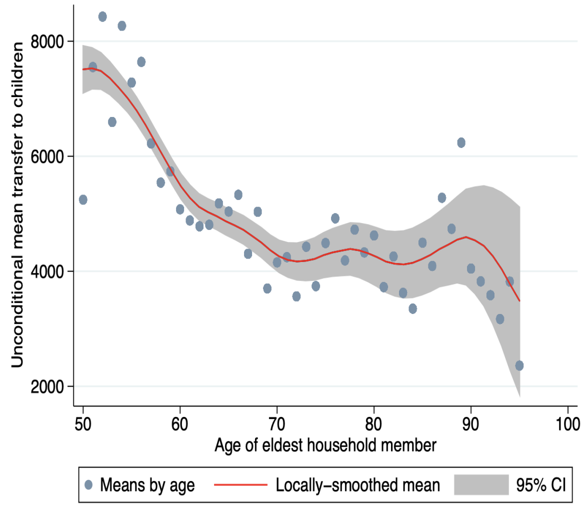
Table 7: Timing and relative size of transfers

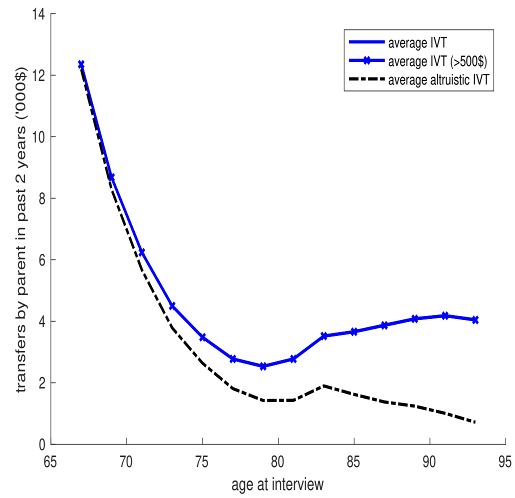
Statistic	Data	Model
IVT-bequest ratio	25.0%	35.3%
	33.3% (Gale & Scholz)	
Age (65+) at which average transfer dollar is given:		
IVT by parent	75.5	74.3
Bequests	83.7	82.6
All transfers together	81.0	80.5

IVT-bequest ratio in the data is based on our own calculation using HRS core interviews, waves 1998-2010, and exit interviews, waves 2004-2012. Gale and Scholz (1994), who use the 1983-86 Survey of Consumer Finances, report that the annual bequest flow and the annual flow of support given by parents to adult family members are 1.06% and 0.32% of aggregate net worth, respectively. IVTs in the model are computed as g^p (altruistic) $+Q^*$ (exchange-motivated).

Figure 8 shows the life-cycle profile of average IVTs in our data and compares it to the model. The model is successful in producing the overall shape: IVTs are higher early in the life cycle but then stabilize at about 2,000$ per year (or 4,000$ bi-yearly, as in the graph—recall that the HRS interviews respondents only every two years). It is unsurprising that the model produces transfers that are too high in the beginning of retirement; this stems from the artifact that kids only start their economic life at that point without wealth and thus receive more help from parents. In reality, most of this help takes place when children are about 18 to 35, which coincides with parents' fifties and early sixties, as is visible in the data series in Figure 8. The figure also shows a decomposition of transfers into altruistic (g^p) and exchange-motivated (Q^*), which we can perform in the model but not in the data. We see that transfers are almost exclusively of an altruistic nature at first, but as

Figure 8: Life-cycle IVTs in data and model





Data (left panel): HRS core interviews, waves 1998-2010. Unconditional mean IVTs by age of the donor. Model (right panel): Average of cumulative transfers over 2-year period from artificial panel, only core interviews used. IVT is $g^p + Q^*$, and altruistic IVT is g^p.

disability becomes more prevalent, exchange-motivated transfers dominate from age 80 onward.

Finally, Table 8 contrasts the bequest distribution generated by the model—no feature of which enters the model calibration—with its empirical counterpart. The model predicts higher bequests for the bottom 50 percent, is almost spot on at the 75th percentile, and produces lower bequests than is observed in the data for the higher percentiles. When we break down the bequest distribution by financial and housing wealth, we can see that the model does very well in terms of predicting housing bequests: 43% of households in the model leave a housing bequest whereas this number is 45% in our data. In terms of the financial component of bequests, the model generates quite a good fit from the median to the 90th percentile, but it generates substantially more households leaving negligible financial bequests than we find in the data.[32]

6 Counterfactuals: Understanding the model

We now use a series of counterfactuals to quantify several effects. We briefly describe the counterfactual environments before discussing the economics behind our main results in Sections 6.1-6.3.

[32]The fact that the model matches the housing and financial-bequest distribution better *separately* than *jointly* (i.e., net worth) tells us that the model fails to replicate the correlation of these bequests in the data. The model generates too little correlation of financial and housing bequests for the wealthy, which manifests itself in lower net worth in the top quantiles. In the same vein, the model generates too little correlation between the two forms at the bottom: it does not generate enough households with negligible total bequests. This may indicate that the model still misses relevant sources of heterogeneity, e.g. in discount factors or altruism towards children.

Table 8: Bequest distribution

	Data				
Bequest	negligible	p50	p75	p90	p95
Total	40%	20	198	521	834
Financial (last IW)	30%	3	53	224	472
Housing (last IW)	55%	0	90	203	326
	Model				
Total	26%	101	203	381	413
Financial	63%	14	83	196	280
Housing	57%	19	123	217	312

Bequests of decedents who at time of death were neither married nor partnered. Bequests are the sum over all children in $000s of year-2010 dollars. Total bequests in the data are calculated from the 2004-2012 exit interviews. The split between financial and housing bequests uses the last HRS core interview prior to death ("last IW") from waves 1998-2010 for the sample of single decedents. We use the last core interview because housing wealth is not separately available in the exit interviews, and we find that wealth at the last core interview is very close to bequests. Respondent-level weights from last core interview available are used for all data values. "Negligible" in the data means ≤ 0 while in the model means it $< 25K$, corresponding to the mid-value of the two lowest grid points. (Adopting the definition of negligible in the model, the corresponding figures in the data would be: 51% of total bequests, 68% of financial bequests, and 60% of housing bequests.) None of the numbers targeted by calibration. p50-p95 refer to percentiles.

Counterfactual environments. In a first counterfactual exercise (*no-kids*), we re-visit the childless economy that we already encountered in the model-validation section. A second scenario (*Sweden*) switches off LTC-expenditure risk; here, we study an economy with full insurance of care needs (i.e., universal insurance without a means test). Specifically, we assume that the government covers the price of formal basic care services, p_{bc}, for anyone who obtains care *formally* at home or in a nursing home, financed through a uniform increase in the payroll tax levied on the working-age population. In a third experiment (*no owning premium*), we set $\omega = 1$, which eliminates the advantage of home-owning over renting. Finally, we study what would happen to homeowners in our model if we forced them to sell their houses; we do this at several points in the life cycle in order to understand the causal effects of owning. An overview of the results from various counterfactuals (and their combinations) is given in Table 12, which we will repeatedly refer to in the ensuing discussion.

6.1 The role of housing

In our model, homeowners differ from renters for two reasons: First, owners are inherently different from renters: they tend to be wealthier, have more productive children, and be healthier (the *selection effect*). Second, owning a home has an effect on agents' economic behavior ceteris paribus (the *causal effect* of owning).

Table 9: Effects of owning at age 65

Variable	renters (13.7%)	owners (86.3%)	clones (86.3%)
net worth (at 65)	15.9K	390.7K	390.7K
exp. disc. bequest	2.6K	116.2K	55.5K
exp. disc. net worth upon LTC	3.3K	123.4K	68.6K
exp. disc. exchange IVT	0.8K	3.9K	7.5K
exp. disc. altruistic IVT	0.6K	38.6K	13.1K
life expectancy	16.09y	18.61y	18.61y
exp. time h-to-m	15.37y	12.03y	6.26y
exp. time in IC	0.10y	1.24y	0.84y
prob. ever LTC	54.6%	54.3%	54.3%
prob. ever rent	100.0%	50.2%	100.0%
prob. ever NH	52.5%	22.9%	35.6%
prob. ever MA	52.4%	10.6%	26.6%

All variables measured at age 65 for homeowners, their *clones*—identical copies who we force to rent—and renters. Nominal variables are discounted at interest rate r. *h-to-m* stands for hand-to-mouth, i.e. households for which consumption equals current income. Second row of table head gives fraction of households belonging to each category. *IVT*: inter-vivos transfer, *IC*: informal care, *NH*: nursing home, *MA*: Medicaid.

1. Selection into home ownership

(a) Selection accounts for about half of the difference between owners and renters in expected future outcomes at retirement. Table 9 compares homeowners at age 65 (86.3% of model households) with renters. In addition, to separate the selection and causal effects, we create *clones* of homeowners whom we (unexpectedly) force to sell their homes at age 65. Clones are thus identical copies of the original households in all respects (pension, health, mortality, net worth, kid's characteristics), so any differences between clones and owners reflect only the causal effect of owning a home.

Comparing the first two columns in Table 9, we see that renters differ substantially from owners. Owners expect to leave much higher bequests than renters, give more transfers to their children, receive more IC, and enter nursing homes and Medicaid less often. The final column of Table 9 shows the results for the owners' clones. Once we deduct the causal effect of ownership, we see that selection accounts for about half the difference between owners and renters (at age 65) in expected bequests, expected IVTs (the sum of exchange and altruistic transfers), and the NH-entry probability, and for about two-thirds of the difference in the Medicaid-entry probability. The rest of the difference is accounted for by the causal effects of owning, which we will discuss further below.

(b) Both selection and causal effects stay relevant at onset of disability. Table 10 shows that the

causal effects of owning persist at the onset of disability. From the top half of the table, we see that among those who ever become disabled (about 54% of the sample), about one-quarter enter disability as renters while three-quarters enter as owners. Although the discrepancies we observed at age 65 shrink due to the inflow of previous owners into the renters' pool, owners are again much richer than renters and can expect to leave larger bequests and IVTs. Selection now accounts for most of the differences between owners' and renters' outcomes (about 90% for expected bequests and about 60% for the NH-entry probability, for example).

The bottom part of Table 10 splits the sample of homeowners at disability onset into those who liquidate (about two-thirds) and those who keep the house (one-third). In this restricted sample, net worth differences between owners and renters are much smaller than at previous points in the life-cycle. Unsurprisingly, liquidators are much more likely to enter nursing homes and eventually Medicaid—in fact, liquidators in the model often sell their homes because they cannot expect IC from their children. Looking at the outcomes of keepers' clones, we now see that the causal effect of owning accounts for a large part of the difference between liquidators and keepers: about half for time spent in IC and the NH-entry probability and about one-third for expected bequests.

2. Causal effects of ownership. We now further zero in on the causal effects of ownership and their timing over the life cycle.

(a) IC becomes more persistent and NH less likely. As in the data, we see that our model generates the observed positive correlation between home ownership and IC—compare renters to owners in Tables 9 and 10—and delivers the regression result from Table 2 that prior home ownership predicts IC. By comparing homeowners to their clones, we see that home ownership *per se* increases the expected time in IC by about half when measured at age 65, by about 5% if measured just before the onset of disability, and by about 12% if measured just after the onset of disability. As for NH (MA) entry, the effect is even stronger: ownership *per se* almost cuts by one-half (two-thirds) the probability when measured at age 65 and just after the onset of disability.

(b) Savings increase. The crucial mechanism behind home-owning's causal effect in the model is that it leads to lower expenditures (for both housing and other consumption). This increases bequests mechanically and so incentivizes children to provide IC for longer and for smaller contemporaneous transfers, which further props up bequests. Table 11 contrasts outcomes for homeowners with what they would have done had they been stripped of their houses in this instant ("contemporaneous clones"). We see that owners' expenditures (on housing, consumption, and care) would increase by at least a third. An important driver behind these behavioral effects is what Kaplan and Violante (2014) refer to as "wealthy hand-to-mouth" households. They voluntarily constrain consumption unless they are hit by a sufficiently large income shock, which for our retired parents corresponds to an LTC event. Tables 9 and 10 show that these expenditure effects are also present when looking forward in time; owners expect to be hand-to-mouth for much longer durations than clones. Table 9 shows that there are substantial effects already *before* the onset of disability: expected net worth for owners at the time of disability is almost double the size of their clones, which makes IC more viable.

Furthermore, owners can expect to obtain IC much more cheaply than clones as can be seen in the "exchange IVT" column of Table 11. Children are more willing to provide IC if they can keep parents from selling the home. These lower IVTs further contribute to the slower wealth spend-down of owners. Finally, almost all effects of housing on care choices are *dynamic* and not contemporaneous. Table 11 shows that almost all owners who receive IC would still receive IC the next day if they sold the house; however, they would then spend down their wealth faster (both on higher expenditures and higher IVTs) making prolonged IC less likely.

3. LTC triggers 60% of home liquidations in retirement. In our model about half (50.2%) of all households who start retirement as owners liquidate their homes before they die. The model predicts that only about one in seven owners (13.3%) sells their home in the time span between retirement and LTC onset, whereas the probability of selling precisely at the onset of disability is about two-thirds (63.7%). Also, *after* the disability shock has hit, the probability drops again: Among owners who keep the house at the onset of disability, less than half (40.3%) then sell the house at some point before death. Expressed in a different way, the model predicts that about six in ten (59.8%) of all home liquidations in retirement are triggered by the LTC shock.[33]

4. Housing-as-commitment accounts for 10% of ownership. As we have seen, parents in our model own homes both because they offer a de-facto higher return and because they are a commitment device that induces IC. We conclude our analysis of the effects of housing by asking how much of ownership is due to the housing-as-commitment channel. To identify this fraction, we consider the counterfactual in which we eliminate the owning premium ($\omega = 1$). Figure 9 shows the cross-sectional rates for this experiment (*no own prem.*) and reports that overall homeownership drops from 74.6% (baseline) to 9.6%. However, we note that agents in the model may own homes since carrying wealth in a home has a slightly higher return than liquid assets since income taxes are paid on interest income but not on the implicit return from housing. We identify this effect by the ownership rate from the counterfactual *no owning premium + no-kids*, which is 2.4% (not shown; note that there is no housing-as-commitment channel for the childless). We thus conclude

[33] Davidoff (2010) presents evidence from the HRS, that (1) exiting ownership is uncommon except when long-term-care needs arise and, (2) that the exit rate spikes in the year of nursing home entry (see his Figure 1). For example, among respondents who first entered a nursing home in 2004, there is an exit rate from ownership of around 10% in prior years, 37% in the year of entry, and 23% in the following wave. Compared to the model, his numbers are lower in part because his sample also includes couples whereas in the model the LTC shock is tied to widowhood.

Table 10: Effects of owning at the onset of disability

Variable (*before* housing decision)	renters (25.3%)	owners (74.7%)	clones (74.7%)
net worth (at LTC entry)	39.0K	171.4K	171.4K
exp. disc. bequest	34.1K	125.5K	115.6K
exp. disc. exchange IVT	13.8K	21.9K	23.9K
exp. disc. altruistic IVT	0.0K	1.8K	0.0K
life expectancy	3.74y	3.92y	3.92y
prob. ever rent	100.0%	78.3%	100.0%
exp. time in IC	1.15y	2.28y	2.18y
prob. ever NH	65.4%	44.4%	50.4%
prob. ever MA	63.6%	18.8%	21.9%
exp. time h-to-m	2.80y	1.45y	0.92y

Variable (*after* housing decision)	liquidators (63.7%)	keepers (36.3%)	clones (36.3%)
net worth (at LTC entry)	147.6K	213.2K	213.2K
exp. disc. bequest	95.3K	178.6K	151.3K
exp. disc. exchange IVT	23.5K	19.0K	24.5K
exp. disc. altruistic IVT	0.0K	4.9K	0.0K
life expectancy	4.09y	3.63y	3.63y
prob. ever rent	100.0%	40.3%	100.0%
exp. time in IC	2.06y	2.65y	2.37y
prob. ever NH	57.5%	21.3%	37.8%
prob. ever MA	26.7%	4.9%	13.3%
exp. time h-to-m	1.16y	1.96y	0.50y

Variables are measured when disability shock hits: (i) before the house-selling decision takes place (upper part of table) and (ii) right after the house-selling decision (lower part of table). *Owners*: Households (hh.) that own home when hit by disability shock. *Renters*: Hh. that were already renting when hit by disability. *Keepers*: Hh. that own home and keep it in the instance disability hits. *Liquidators*: Hh. that own but decide to sell in the instance disability hits. *Clones*: Identical copies of owners/keepers whom we force to sell home in the instance disability hits. *h-to-m*: hand-to-mouth, i.e. hh. for which consumption equals current income. Second row of table headers: (i) percentage out of all hh. hit by disability (upper part), (ii) percentage out of all hh. that own when hit by disability. *IVT*: inter-vivos transfer, *IC*: informal care, *NH*: nursing home, *MA*: Medicaid.

Table 11: Behavioral effects of home-owning

Group	expenditure	IC	exchange IVT	h-to-m
healthy	53.4K	–	-0.5K	71.6%
healthy clones	70.2K	–	0.0K	0.0%
disabled	34.3K	84.8%	4.1K	79.7%
disabled clones	48.3K	82.3%	6.9K	0.0%
receiving IC	24.1K	100.0%	4.9K	92.2%
IC clones	40.4K	96.0%	7.9K	0.0%

Spending behavior in cross-section of home-owning agents by health status and informal care (IC). *Clone*: Identical copy of an agent whom we force to sell the home. *h-to-m*: hand-to-mouth (i.e. consumption equals current income). *Expenditure*: Spending on consumption + housing (rent for renters, depreciation plus foregone interest for owners) + spending on formal care (NH and FHC). *Exchange IVT*: Net transfer Q between parent and children resulting from joint bargaining over home-selling and informal care.

that about one-tenth ($\simeq \frac{9.6-2.4}{74.6}$ =9.9%) of ownership is accounted for by the commitment channel.

6.2 The role of the family

In this section, we analyze in more detail how the family (i.e., the presence of children) matters for economic behavior of the elderly.

1. Similarity of childless' and parents' savings driven by LTC risk. In our model, children have ambiguous effects on parents' savings. On the one hand, children dis-incentivize precautionary savings as they provide insurance (*family-insurance* channel).[34] On the other hand, children give parents an incentive to save since the altruistic parent wishes to give transfers in the future, both in the form of bequests and IVTs (*altruistic-savings* channel). We note here that, unlike a childless agent, an altruistic parent values savings even in the state in which they are dead; following Lockwood (2018), we call this the *incidental valuation* of savings. This incidental valuation depends in part on the economic well-being of one's children: the more well-off they are compared to their parents, the lower the incidental value is.[35]

We now discuss a series of counterfactuals that disentangle the countervailing effects of children on savings; see Table 12. As discussed in the model-validation section, the *no-kids* counterfactual generates savings and bequest behavior that is similar to the baseline, which is in line with empirically observed facts.[36] Both the altruistic-savings and family-insurance channels are switched off for the childless, from which we conclude that the two roughly cancel out in the U.S. economy. We now switch off LTC risk in order to isolate the altruistic-savings channel; we do this by comparing the counterfactuals *Sweden* and *Sweden + no-kids*. We see that the results are dramatic: bequests almost disappear for the childless in Sweden. However, initial retirement wealth is not much affected, thus the main effect is that the childless run down their assets a lot faster when insured against risk. This effect is especially strong at the higher wealth percentiles; rich parents have low marginal utility and thus become increasingly concerned about their children's future consumption (consistent with the *luxury-good* nature of bequests, as estimated by Lockwood, 2018).

2. Incidental valuation is crucial for high home ownership. We will now show that the

[34] The family-insurance channel can again be broken up into an *IC-insurance* channel (the fact that parents can receive care from a cheaper source than the market) and a *gift-insurance* channel (the fact that parents receive financial transfers from altruistic children). In the calibrated model, gifts by children are very low, thus the family-insurance channel is overwhelmingly driven by the the IC-insurance channel.

[35] This represents a crucial departure from the incidental motive in Lockwood (2018) and in other papers that employ the egoistic bequest motive, in which the parent's valuation is independent of the recipient's resources.

[36] The reason for the lower bequest numbers in the table here, is that they also include childless individuals alive at age 95, which have zero bequests as they face death with certainty. For model validation, we relied on a model-generated panel constructed in line with the HRS.

Table 12: Counterfactual exercises

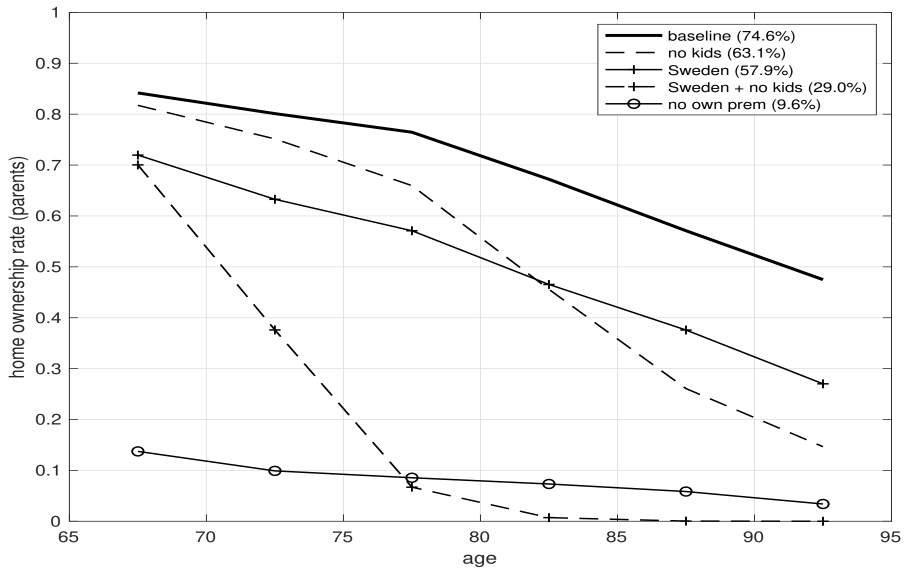
Wealth: Ages 65-70	p10	p25	p50	p75	p90
baseline	15	86	203	435	712
no kids	-9	-6	+8	+35	+11
Sweden	-15	-28	-32	-9	-23
Sweden+no kids	-15	-36	-39	-12	-40
no own. premium	-15	-62	-49	+23	+22
no own. premium+no kids	-15	-65	-64	+20	+6
no own. premium+Sweden	-15	-69	-87	-28	-40
no own. premium+no kids+Sweden	-15	-70	-94	-56	-94

Bequests	Negligible	p50	p75	p90
baseline	26%	101	203	381
no kids	+11%	-35	-26	-101
Sweden	+18%	-47	-24	-20
Sweden+no kids	+49%	-93	-178	-229
no own. premium	+37%	-87	-118	-92
no own. premium+no kids	+39%	-88	-127	-174
no own. premium+Sweden	+54%	-95	-181	-261
no own. premium+no kids+Sweden	+57%	-96	-183	-291

LTC provision (%)	IC	FHC	NH	MA
baseline	51.2	2.5	16.5	29.8
no kids	NA	+3.8	+24.9	+22.6
Sweden	-51.2	+0.9	+80.1	-29.8
Sweden+no kids	NA	+1.0	+80.0	-29.8
no own. premium	-17.7	-2.5	-2.8	+23.0
no own. premium+no kids	NA	-2.5	+12.2	+41.5
no own. premium+Sweden	-51.2	-2.5	+83.5	-29.8
no own. premium+no kids+Sweden	-51.2	-2.5	+83.5	-29.8

Counterfactual experiments. Wealth and bequests are in 000s of 2010-dollars. *Negligible* is $\leq$ 25K. *p10*, *p25*, ..., *p90* are the 10th, 25th, ..., and 90th percentiles. *no kids:* parent generation ages 65-95 has no children. *Sweden:* price of formal basic care services is paid for by the government. *no own. premium:* no extra-utility from owning versus renting a home, $\omega = 1$. *IC*: informal care, *FHC*: formal home care, *NH*: nursing home, *MA*: Medicaid.

Figure 9: Counterfactuals: homeownership rate by age



Cross-sectional home-ownership rates in baseline model and selected counterfactual scenarios (described in text). 5-year age bins: $[65-70)$, $[70-75)$ etc.

incidental-valuation channel is especially strong for the housing asset, less so for financial assets. Consider the *Sweden* environment, in which the family-insurance channel is switched off. When we remove children (scenario *Sweden* + *no-kids*), Figure 9 shows that the overall home-ownership rate is cut in half (from 58% to 29%)—a striking decrease that is entirely due to the childless having no incidental valuation of the housing asset. As the childless age, holding on to the home becomes less desirable: LTC risk increases and life expectancy decreases, but the savings locked up in a house yield zero return to the childless in the event of death. In fact, the homeownership rate is close to zero for ages exceeding life-expectancy in the model which is around 83 years.

6.3 What is the bequest motive?

Finally, we draw some lessons from our model in regards to the long-standing question of why people leave bequests.

1. No single bequest motive. Most importantly, our model suggests that the quest to find *the* (single) bequest motive may be bound to frustrate. Instead, what is needed is an eclectic model of bequests. This implication is consistent with Kopczuk & Lupton (2007), who argue that bequest motives appear to be heterogeneous. Our model can provide a first step in organizing and understanding this heterogeneity, at least for the bottom 90% of the wealth distribution. Our model also offers an alternative explanation to the egoistic motive for why so many childless households leave bequests: they face higher risks, especially in the form of LTC.

2. Illiquid housing is an important driver of bequests. Although interactions are omnipresent, one channel stands out in our model: housing as an illiquid asset with a superior return. This channel is often overlooked in the literature on bequest motives (Nakajima & Telyukova, 2018 being a notable exception).

3. Altruism matters little *per se*, more so through its interactions with housing. In isolation, the altruistic bequest motive is a relatively small contributing factor to bequests in our model. In a world with neither LTC risk nor a premium for owning a home, our counterfactuals indicate that parents and the childless would leave roughly the same (very low) bequests. This is no longer true when we switch on the owning premium, however: in this case, the bequests left by parents become much larger than those of the childless. Hence, we see that altruism matters for bequests primarily through its interaction with the housing asset.

4. Family insurance has countervailing effects on bequests. In addition to altruism, the other mechanism offered by the literature for describing how children matter for bequests is the exchange motive. This idea is closely tied to the family-insurance channel in our model: bequests (along with IVTs) act as compensation for informal care provided by children. Our model presents a nuanced picture of the importance of this mechanism. On the one hand, informal care protects assets from being spent-down on nursing homes and thereby leads to higher bequests. Thus, we see higher bequests in families with IC arrangements than those with NH arrangements. On the other hand, we note that the *possibility of exchange* also has a *negative* effect on bequests: if we remove the IC technology from the family, the financial risks from LTC increase, driving up precautionary savings and thus accidental bequests.

5. The rich are different. Our model fails to match the upper tail of the bequest distribution despite the inclusion of a rich—and arguably realistic—set of reasons for why people leave bequests. This result indicates that the rich have strong concerns for holding wealth that go well beyond those present in our model.[37] Motives for the rich may plausibly be along the lines suggested by Carroll (2000) wherein wealth is either an end in itself or yields flow services in the form of power or social status.

7 Conclusions

We conclude by noting several implications of our results for future research and for policy. First, drawing inferences based on comparisons between parents and childless individuals is valid only if

[37] This matters especially for studying estate taxation since only the very richest (about the top 0.2%) pay such taxes in the U.S. (Joint Committee on Taxation, 2015).

their differing risks and saving incentives are taken into account. Second, in a dynamic setting, the existence of an exchange motive for bequests can lead to *lower* bequests as the forward-looking agent also engages in less precautionary savings. Third, our model suggests that the elasticity of bequests to modest estate taxes is likely to be minor as individuals prefer to hold on to wealth—instead of transferring it early—and leave bequests due to the interplay between the presence of children and LTC risks and less because of altruism *per se*. Finally, even though we only allow for Markov strategies, the threat of selling the house if care is not given becomes an unspoken and credible form of dis-inheritance, despite the absence of a written will.

While the focus of our paper was on the economic behavior of the elderly in the U.S., our model also has the potential to explain cross-country differences in old-age behavior. For example, according to our model, in countries where old-age risks are relatively well-insured—e.g., Sweden—homeownership rates should be lower and dis-saving should be faster than in comparable countries with higher uninsured risks.[38] These predictions also provide insights for policy makers into the possible unintended consequences of policies. For example, making formal-care insurance more generous means less informal care and a reduction in homeownership rates, which further reduces and shortens informal-care arrangements, increasing the costs of the policy. Policy makers concerned with reforms in the housing market should bear in mind that ownership also impacts the care decisions of the elderly and can make prolonged nursing-home stays more or less likely, depending on the reform.

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[38] Indeed, Nakajima & Telyukova (2019) and Bueren (2018) document this to be the case in the data.

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Appendix

A Data appendix

A.1 Sample selection

We utilize two samples from the Health and Retirement Study (HRS) for our analyses. We refer to these samples as the "decedent sample" and the "full sample."

A.1.1 Decedent sample

Our sample of decedents includes a subset of individuals with an exit interview in the 2004-2012 waves of the HRS who were single (neither married nor partnered) at the time of death.[39] Additionally, we exclude cases where:

- The proxy either did not know or refused to provide the status of the home.
- The proxy listed the spouse as the inheritor or recipient of the home or did not know or refused to identify who inherited the home (if held until after death) or whom the home was given to (if disposed of prior to death).
- The decedent had no non-missing individual sample weights for any core interview in our 1998-2010 sample period.
- The proxy did not know, refused to answer, or was not asked whether the decedent had either a will or trust or both.
- The date of death was reported to have occurred prior to the decedent's most recently given core interview.

The primary rationale behind most of these criteria is to retain only observations where the proxy interviewee had sufficiently high quality information about the decedent's estate. We combine the exit interview data for these decedents with data from their core interviews given in the 1998-2010 waves of the HRS. For hours of long-term care and types of long-term care arrangements, we use data only from 2002 and later.

[39] We begin with the 2004 exit interview data because certain important questions concerning homes were not asked for a subset of home-owning decedents in 2000 and 2002. Although the HRS took steps to correct the problem (by conducting estate call-back interviews), the data remain incomplete for many decedents in these years.

A.1.2 Full sample

The core interview sample includes all individuals that appear in the RAND Longitudinal File in the 1998-2010 waves of the HRS. This sample includes only core interview data. We compute calibration targets and bi-annual inter-vivos transfer flows using this sample. As for decedents, for hours of long-term care and types of long-term care arrangements, we use data only from 2002 and later.

A.2 Bi-annual bequest and inter-vivos transfer flows

Inter-vivos transfers to children are taken from the RAND Family Files. RAND imputes missing transfer values using a similar procedure to the one they use to impute missing values of income and wealth and which we have used to impute estate values. Bequest (estate) values are as we have described above. To compute bequest flows, we assign decedents' bequests to their final core interview wave rather than the wave in which their exit interview was given. We consider only bequests left by individuals with children, as defined by the number of children listed at the exit interview. For each wave, all inter-vivos transfer and bequest flows are summed across all individuals. For these summations, although these flows are household variables, we use individual respondent-level sample weights rather than household weights because the former have been corrected for nursing home residents while the latter have not. (The HRS generally assigns zero weight to nursing home residents. Because a large share of decedents live in nursing homes at the time of their last core interview, assigning these individuals zero weights could lead us to significantly undercount bequest flows.) Finally, we take the ratio of inter-vivos transfers to bequests. In all calculations, we consider only households whose eldest member is 65 years of age or older.

A.3 Long-term care categories and hours of care

To measure hours of long-term care, we use data from 2002 and beyond, which corresponds to when the HRS fully standardized their coding of these variables. We top-code hours of care from any particular non-institutional (non-nursing home) caregiver at 16 hours per day for 31 days per month. In cases where hours of care are missing for a non-institutional caregiver, we impute hours for that caregiver using a nearest neighbor match routine. Neighbors are matched using fitted values from a regression of (the inverse hyperbolic sine of) care hours on a care recipient's age, gender, and ADL and IADL limitations; indicators of a caregiver's relative importance (based on the order caregivers are listed) in helping with ADLs, IADLs, and managing money, plus indicators for whether care was also received from another helper who was a spouse, partner, or nursing home; and interactions of many of these variables. A single nearest neighbor is selected with replacement, and ties are broken randomly. Fitted values and matching are done separately for core and exit interviews. Following the imputations, hours are summed by category of helper and then across all categories to obtain total monthly hours of care.

The HRS does not elicit hours of care from institutional (nursing home) helpers. For individuals who receive some (any) nursing home care, we impute total monthly care hours using a separate nearest neighbor match procedure. Here we match care recipients in nursing homes with similar care recipients living in the community on the basis of fitted values for (the inverse hyperbolic sine of) total monthly hours of care. Covariates in this regression are: an indicator for an exit interview; an indicator for a proxy core interview; age; an indicator for ever having memory disease; and ADL and IADL limitations, included linearly, squared, and interacted.

Among all of the interviews for care recipients in our sample of single elderly decedents, 58.7% are not missing hours data for any helpers. No imputations are done in these cases. Another 32.1% are missing hours data only for institutional helpers, which the HRS does not record. For these individuals, only total monthly hours are imputed. Only 9.2% of the interviews for care recipients in our sample are missing care hours data for a non-institutional helper. For these individuals, we impute hours of care for the caregivers with missing hours data. If these individuals also receive institutional care, we separately impute total care hours.

To construct a summary measure of care during the sample period for decedents (used in the regression analyses), we compute average weekly hours of care as follows. We assume that the total monthly hours of care reported at each interview are provided at the same rate in every month since the prior interview. We sum these hours across all months in the sample period (the part that overlaps with the period covered by the 2002 and later interview waves) and divide by the number of weeks that elapsed in this period.

We categorize long-term care arrangements using source of care as follows. Individuals who receive any nursing home care or who reportedly live in a nursing home are classified as in a nursing home. Individuals who do not receive nursing home care and who received more than 50% of their care hours from informal sources (family or other unpaid individuals) are classified as receiving informal care. The remaining individuals, who are not in nursing homes and who received less than 50% of their care from informal sources, are classified as formal home care recipients.

An individual is classified as disabled (sick) if the individual is both not coupled and receives 90 or more total hours of care per month. If either of these criteria are not satisfied, an individual is considered not disabled (healthy).

Table A1: Distribution of liquid (non-housing financial) wealth

(a) All respondents, ages 65-69

	N	Mean	p10	p25	p50	p75	p90	p95
Children	13,568	149	-3	0	13	98	334	626
No Children	1,008	172	-0	0	22	166	431	737
All	14,576	151	-2	0	13	103	346	632

(b) Single decedents, last core interview

	N	Mean	p10	p25	p50	p75	p90	p95
Children	2,866	97	-0	0	3	48	210	434
No Children	358	132	0	0	6	88	344	620
All	3,224	101	-0	0	3	53	224	472

Note: Panel (a): HRS core interviews 1998-2010. Full sample of HRS respondents with data in this period. For couples, one observation is selected per household per interview. Age is determined using the age of the eldest household member. Panel (b): HRS exit interviews 2004-2012. Decedents who at time of death were neither married nor partnered. Child status is determined according to the number of children listed at the exit interview. In both panels, non-housing financial wealth is defined to include the net value of stocks, mutual funds, and investment trusts; the value of checking, savings, or money market accounts; the value of CD, government savings bonds, and T-bills; the net value of bonds and bond funds; and the net value of all other savings; less the value of other debt. Dollar values are in 1000s of year-2010 dollars. Respondent-level weights used.

Table A2: Annualized wealth changes and homeownership

	Quantiles of annualized changes in wealth between interviews				
	10th	25th	50th (median)	75th	90th
Own (t-1)	3,309***	6,818***	8,133***	8,709***	8,339***
	(469)	(917)	(340)	(459)	(3,150)
N	12,205	12,205	12,205	12,205	12,205
Quantiles of Y	-73,089	-18,505	-86	10,402	61,717

(a) Controlling for t-1 wealth deciles only

	Quantiles of annualized changes in wealth between interviews				
	10th	25th	50th (median)	75th	90th
Own (t-1)	3,586***	6,474***	9,039***	10,505***	11,086***
	(547)	(583)	(321)	(628)	(2,404)
N	8275	8275	8275	8275	8275

(b) Full controls

	Quantiles of annualized changes in wealth between interviews				
	10th	25th	50th (median)	75th	90th
Own (t-1)	3,374***	6,978***	10,064***	15,571***	13,050
	(669)	(1,904)	(1,389)	(1,819)	(10,112)
N	1247	1247	1247	1247	1247

(c) Individuals in informal care arrangements at prior interview

	Quantiles of annualized changes in wealth between interviews				
	10th	25th	50th (median)	75th	90th
Own (t-1)	2,756	6,150***	7,129***	9,231***	6,664
	(1,781)	(2,047)	(1,462)	(2,848)	(13,790)
N	739	739	739	739	739

(d) Individuals in informal care arrangements at the current and prior interview

Note: Robust standard errors in parentheses. * p<.1, ** p<.05, *** p<.01. Core interviews from the period 1998-2010 for our sample of decedents. Estimates are from quantile regressions in which the dependent variables are quantiles of the change in wealth between adjacent core interviews divided by the number of years between interviews. The table reports coefficient estimates for the key regressor of interest: an indicator for homeownership at the previous interview. Controls include: deciles of wealth from the previous interview, age, sex, indicators for black or other non-white, an indicator for hispanic ethnicity, indicators for education levels (high school or GED, some college, college and beyond), an indicator for being coupled, numbers of ADL and IADL limitations (separately), an indicator for ever having memory disease, indicators for each of three possible care arrangements (informal home care, formal home care, and nursing home care), and indicators for each interview wave. Informal care is defined as not receiving nursing home care and receiving more than 50% of care from informal sources (family or other unpaid individuals). The large reduction in sample size between panels (a) and (b) is due to missing information for care arrangements before 2002. The further declines in panels (c) and (d) are from sample restrictions. For panel (c), the sample is restricted to individuals in informal care arrangements at the previous interview. For panel (d), the sample is further restricted to individuals who were in informal care arrangements at the previous and current interview. Panels (c) and (d) utilize the full set of controls listed above except for the care arrangement indicators. The notation "t-1" refers to the previous core interview.

Table A3: Bequests and informal care

	Results in text		with NH control		Renters only		Owners only	
	Any Estate	Log Value	Any Estate	Log Value	Any Estate	Log Value	Any Estate	Log Value
Avg wkly LTC hours	-0.0017***	-0.0034***	-0.0012***	-0.0014	-0.0012***	-0.0056	-0.0016***	-0.0020*
	(0.00023)	(0.0012)	(0.00024)	(0.0012)	(0.00037)	(0.0034)	(0.00027)	(0.0012)
Avg wkly child LTC hours	0.0011***	0.0053**	0.00044	0.0023	0.00036	0.0020	0.00089*	0.0037*
	(0.00039)	(0.0022)	(0.00040)	(0.0022)	(0.00059)	(0.0083)	(0.00046)	(0.0020)
Ever in NH			-0.10***	-0.44***				
			(0.017)	(0.089)				
Observations	3221	1855	3221	1855	992	290	2222	1563
Adjusted R^2	0.205	0.231	0.213	0.240	0.163	0.236	0.139	0.216
Mean of Y	0.63	11.5	0.63	11.5	0.35	10.1	0.76	11.8

Note: Robust standard errors in parentheses. * p<.1, ** p<.05, *** p<.01. The dependent variables are *Any Estate*, an indicator equal to 1 if the decedent left anything of value to her heirs, and *Log Value*, the log of the estate value. *Average wkly LTC hours* and *Average wkly child LTC hours* are the average number of weekly hours of care received in total and from the younger generation, respectively, during the sample period. These are calculated assuming that LTC hours reported at an interview are constant throughout the period described by that interview. We then cumulate hours from all interview periods and divide by the amount of time (in weeks) covered by the interviews. *Ever in NH* is an indicator equal to 1 if the decedent was ever reported to be living in a nursing home. Other controls include: age at death, years of schooling, an indicator equal to 1 if the respondent was ever married or partnered in the observation period and 0 otherwise, an indicator for any children and the number of living children at the time of death, the (inverse hyperbolic sine of) mean household income across all available core interviews. Specifications also include indicators for each exit interview wave and a constant term. All models are estimated with ordinary least squares. In the specifications labeled *Renters only*, the sample is restricted to individuals who never report owning homes. In the specifications labeled *Owners only*, the sample is restricted to individuals who are ever reported to be homeowners at any point in the sample.

Table A4: Housing bequests and informal care

	Results in text		with NH control	
	Home Bequest	Home Beq. or IVT	Home Bequest	Home Beq. or IVT
Avg wkly LTC hours	-0.0020***	-0.0018***	-0.00092***	-0.00080***
	(0.00022)	(0.00025)	(0.00023)	(0.00026)
Avg wkly child LTC hours	0.0015***	0.0020***	-0.000062	0.00067
	(0.00038)	(0.00042)	(0.00038)	(0.00042)
Ever in NH			-0.23***	-0.20***
			(0.018)	(0.019)
Observations	3223	3223	3223	3223
Adjusted R^2	0.089	0.071	0.132	0.102
Mean of Y	0.36	0.48	0.36	0.48

Note: Robust standard errors in parentheses. * p<.1, ** p<.05, *** p<.01. *Bequest* is an indicator equal to 1 if a decedent died owning a home and 0 otherwise. *Beq. or IVT* is equal to 1 if any of the following are true: a decedent (i) died owning home, (ii) disposed of a home prior to death by giving the home away, (iii) ever reported living in a home owned by her children which she had previously owned, (iv) ever gave a home deed to a child, or (v) ever gave a home to someone. If none of the above are true, the variable is equal to 0. *IVT* stands for "inter-vivos transfer." *Average wkly LTC hours* and *Average wkly child LTC hours* are the average number of weekly hours of care received in total and from the younger generation, respectively, during the sample period. These are calculated assuming that LTC hours reported at an interview are constant throughout the period described by that interview. We then cumulate hours from all interview periods and divide by the amount of time (in weeks) covered by the interviews. *Ever in NH* is an indicator equal to 1 if the decedent was ever reported to be living in a nursing home. Other controls include: age at death, years of schooling, an indicator equal to 1 if the respondent was ever married or partnered in the observation period and 0 otherwise, an indicator for any children and the number of living children at the time of death, the (inverse hyperbolic sine of) mean household income across all available core interviews. Specifications also include indicators for each exit interview wave and a constant term. All models are estimated with ordinary least squares.

Table A5: Informal care and nursing home entry

	Prob NH (t) | not NH (t-1)		
		with Controls for:	
		Homeownership	+ Health (t-1)
	(1)	(2)	(3)
Receiving IHC (t-1)	-0.078***	-0.073***	-0.051***
	(0.010)	(0.010)	(0.012)
Own (t-1)		-0.034***	-0.038***
		(0.011)	(0.011)
N	7215	7126	7119
Mean of Y	0.14	0.14	0.14

Note: Standard errors clustered at the household level in parentheses. * p<.1, ** p<.05, *** p<.01. *Receiving IHC* is an indicator for receiving informal home care, which is defined as not receiving nursing home care and receiving more than 50% of care hours from informal sources (family or other unpaid individuals). *Own* is an indicator for home ownership. *t-1* refers to the previous interview. In all columns, controls include: deciles of wealth from the previous interview, age, sex (indicator for female), race (indicators for black, other non-white), indicator for Hispanic ethnicity, education (indicators for HS, some college, or college and beyond), indicator for being coupled, numbers of ADL and IADL limitations (separately), and an indicator for ever having memory-related disease. The second and third columns adds home ownership at the previous interview. The third column add numbers of ADL and IADL limitations (separately) and an indicator for memory-related disease from the previous interview.

B Theory appendix

B.1 Care technologies and the government

We assume the following linear production technologies for the consumption good (indexed by c), basic care services in nursing homes (bc), and formal-home-care services (fhc):

$$Y_c = L_c, \qquad Y_{bc} = A_{bc} L_{bc}, \qquad Y_{fhc} = A_{fhc} L_{fhc}, \tag{2}$$

where Y_i is the quantity produced in sector i, L_i is the labor input, and A_i is productivity. We normalize $A_c = 1$. Markets for the three goods are perfectly competitive, thus firms' profits are zero equilibrium prices of care in terms of the consumption good are

$$p_{bc} = \frac{1}{A_{bc}}, \qquad p_{fhc} = \frac{1}{A_{fhc}}. \tag{3}$$

The government provides Medicaid slots, paying p_{bc} for care services from nursing homes and y_{ma} units of the consumption good to provide for room, board etc. y_{ma} is a parameter for which we allow $y_{ma} > C_{ma}$, since Medicaid may have stigma effects.

The government that runs a balanced budget in each period. The budget constraint is

$$\begin{aligned} &\underbrace{\int \left[T^p(z) + T^k(z, i^*(z))\right] \mathrm{d}\lambda(z)}_{\text{tax revenue}} \\ &= \underbrace{\int (1 - i^*(z)) \Big[m^*(z) \big(p_{bc} + y_{ma} - y_{ss}(\epsilon^p) \big) + (1 - m^*(z)) s_{pp} \Big] \mathrm{d}\lambda(z)}_{\text{spending on Medicaid and formal-care subsidy}} \\ &+ \underbrace{\int \int \left[\max\{M - a^p, 0\} \mathrm{d}F_m(M) \right] \delta_m(z) \mathrm{d}\lambda(z)}_{\text{means-tested benefits covering medical expenditures}} + \underbrace{G}_{\text{other expenditures}} \end{aligned} \tag{4}$$

where $i^*(\cdot)$ and $m^*(\cdot)$ are the equilibrium policy functions for IC and MA and where $\lambda(z)$ denotes the ergodic measure of families over the state space in equilibrium. $T^p(\cdot)$ and $T^k(\cdot)$ are tax functions on parents and kids. G are other government expenditures, which we hold constant across counterfactuals. s_{pp} is a subsidy to formal-care services (both in nursing homes and at home); this subsidy is zero in the baseline and in all counterfactuals except *Sweden*, in which we set it equal to p_{bc}. In this budget constraint, we omit revenue to the government from assets (a^p) and transfers ($Q + g^k$) that fall prey to the Medicaid means test; these are zero in equilibrium since the parent endogenously spends down all resources before entering Medicaid.

B.2 Agents' problems

Here, we characterize the agents' problems by stating the Hamilton-Jacobi-Bellman (HJB) equations. We will do so by backward induction over the five stages of the instantaneous game. For this purpose, let $V^{u,n}(\cdot)$ denote the value function for player $u \in \{k, p\}$ in stage $n \in \{1, \dots, 5\}$; we denote by $V^u = V^{u,1}$ the value function before the first stage. Let $H^{u,n}(\cdot)$ denote the corresponding Hamiltonian functions, which take the vector $V_a \equiv [V^k_{a^k}, V^k_{a^p}, V^p_{a^k}, V^p_{a^p}]$ of the partial the derivatives of *both* players' value functions as their arguments.[40] Furthermore, denote by $y_{u,n}$ player u's flow-income-on-hand in Stage n of the game, which is determined by decisions in the stages before n; also, let $y_n \equiv [y_{k,n}, y_{p,n}]$ denote the vector of both incomes. Since Stages 3 to 5 are about temporary decisions that involve only flow variables, we use the Hamiltonians to characterize decisions in these stages. However, we then have to switch to the value functions for Stages 1 and 2 since decisions in these stages have permanent effects on the state variables. We refer the reader to Appendix B.3 for details.

Stage 5 (consumption). We will first state an indirect felicity function to facilitate the exposition. Denote by e^u household u's expenditure flow on housing and consumption jointly. Given a fixed expenditure level e^u, the split between consumption and housing is determined from the problems

$$\tilde{u}^k(e^k; z) = \max_{c^k \geq 0, \tilde{h}^k \geq 0} u\big(c^k, \tilde{h}^k; n(j^k, s)\big) \qquad (5)$$

$$\text{s.t. } c^k + (r + \delta)\tilde{h}^k \leq e^k,$$

$$\tilde{u}^p(e^p; z, m) = \begin{cases} \max_{c^p \geq 0, \tilde{h} \in \tilde{H}(h)} u\big(c^p, \tilde{h}^p; n(j^p, s)\big) \ \text{ s.t. } \ c^p + E_h(h; \tilde{h}) \leq e^p & \text{if } m = 0, \\ \frac{C_{ma}^{1-\gamma}}{1-\gamma} & \text{if } m = 1. \end{cases} \qquad (6)$$

Note here that the child always rents and the parent consumes the consumption floor when in Medicaid ($m = 1$). Appendix B.3 derives the functional form of $\tilde{u}^k(\cdot)$ and $\tilde{u}^p(\cdot)$. Using these indirect utility functions and taking the decisions from the previous stages (IC, housing, gifts and

[40] The derivatives of the other player's value function enter here since decisions of both agents are intertwined (i.e. we are dealing with a game instead of the more usual situation of a one-player optimization problem).

MA) and Stage-5 incomes as given, the Stage-5 Hamiltionians are

$$H^{k,5}(z, V_a; y_5, i, m) = \max_{e^k \in \mathbb{E}^k} \left\{ \alpha^k \tilde{u}^p(e^p; z, m) + \tilde{u}^k(e^k; z) + \dot{a}^p V^k_{a^p} + \dot{a}^k V^k_{a^k} \right\}, \tag{7}$$

$$H^{p,5}(z, V_a; y_5, i, m) = \max_{e^p \in \mathbb{E}^p} \left\{ \tilde{u}^p(e^p; z, m) + \alpha^p \tilde{u}^k(e^k; z) + \dot{a}^p V^p_{a^p} + \dot{a}^k V^p_{a^k} \right\}, \tag{8}$$

$$\text{where} \qquad \mathbb{E}^u = \begin{cases} [0, \infty) & \text{if } a^u > 0, \\ [0, y_{u,5}] & \text{otherwise,} \end{cases}$$

$$\dot{a}^u = \begin{cases} 0 & \text{if } u = p \text{ and } m = 1, \\ y_{u,5} - e^u & \text{otherwise.} \end{cases}$$

This says that both players optimally trade off instantaneous felicity and the marginal value of savings. Note here that consumption cannot exceed flow income once wealth is depleted ($a^j = 0$), in which case the agent may be constrained.[41] Parents in MA are bound to consume the consumption floor given to them by the government and cannot save.[42]

Stage 4 (Medicaid). We guess for now that the parent will only choose MA once she has zero assets. We will later verify that the parent's value function is increasing in a^p, which is sufficient for this choice to be optimal.[43] Given the IC decision, i, and Stage-4 incomes, y_4, the Stage-4 Hamiltonians are

$$\begin{aligned} H^{u,4}(z, V_a; y_4, i) = {} & m H^{u,5}(z, V_a; [y_{k,4}, C_{ma}], 0, 1) \\ & + (1-m) H^{u,5}(z, V_a; [y_{k,4}, y_{p,4} - p_{pp}(h)], i, 0), \qquad \text{for } u \in \{k, p\}, \end{aligned} \tag{9}$$

$$\text{where} \qquad m = \begin{cases} 1 & \text{if } s = 1 \text{ and } i = 0 \text{ and } a^p = 0 \text{ and} \\ & H^{p,5}(\cdot; [y_{k,4}, C_{ma}], 0, 1) > H^{p,5}(\cdot; [y_{k,4}, y_{p,4} - p_{pp}(h)], 0, 0), \\ 0 & \text{otherwise.} \end{cases}$$

$$\text{and} \quad p_{pp}(h) = \mathbb{I}(h = 0) p_{bc} + \mathbb{I}(h > 0) p_{fhc}.$$

The second equation gives the optimal MA decision, which is relevant only if the family has decided for formal care ($s = 1$ and $i = 0$) and the parent has no financial wealth ($a^p = 0$). The parent chooses MA if the value from doing so in Stage 4 is higher than that of choosing private-

[41] Also, we formally allow for negative flow income for the parent in Stage 5, $y_{p,4} < 0$, in which case we set $\mathbb{C}^p = \emptyset$ and $H^p_5 = -\infty$. This occurs when the nursing home cost exceeds the parent's income.

[42] We are not covering the the case when parents choose Medicaid having positive financial assets, $a^p > 0$, in which case they would lose a^p; we rule this case out by guess-and-verify, see Stage 4 (Medicaid).

[43] To see this, note that the parent could always delay MA by an instant, buy PP instead, and choose expenditure $e^p > C_{ma}$ as a renter. This strategy obviously yields a higher utility flow and higher assets (and thus more future options) after an instant $\mathrm{d}t$ than handing in a positive stock of wealth to the government.

payer (PP) care. The last line specifies that when paying privately for care, renters pay the price of basic care in a nursing home, p_{bc}, while owners pay the price for FHC, p_{fhc}.

Stage 3 (gift-giving). Since the decisions in Stages 1 and 2 entail permanent changes in the state variables, we now switch from Hamiltonians to value functions in levels. Given the IC decision and Stage-3 incomes, the Stage-3 values satisfy the HJBs

$$V^{u,3}(z,V_a;y_3,i) = V^u(z) + \mathrm{d}t\Big[\max_{g^u\in\mathbb{G}^u} H^{u,4}(z,V_a;[y_{k,3}+g^p-g^k, y_{p,3}-g^p+g^k],i)\Big] \\ + \mathrm{d}t\Big[V^u_{j^u}(z) - \rho V^u(z) + J^u(z)\Big] \qquad \text{for } u\in\{k,p\} \tag{10}$$

,

$$\text{where} \qquad \mathbb{G}^u = \begin{cases} \big[0,\bar{T}_u(z)\big) & \text{if } a^u > 0, \\ \{0\} & \text{if } u = p \text{ and } s = 1 \text{ and } i = 0 \text{ and } a^p = 0, \\ [0, y_{u,3}] & \text{otherwise,} \end{cases}$$

where we recall that $V^u(\cdot)$ denotes the value function before Stage 1 and where $\{\bar{T}_u(z)\}_{u\in\{k,p\}}$ are (large) exogenous bounds that we impose on transfer flows.[44] The age derivative $V^u_{j^u}$ enters in this HJB since age is a state variable. $J^u(z)$ stands for a series of jump terms, encoding shocks to productivity, health, and medical spending, see the appendix for the definition. Players choose non-negative gift flows, which are constrained to their income-on-hand in case they have zero wealth. We rule out gifts by parents in formal care when they have zero wealth. In line with previous work by Barczyk & Kredler, we find that the vast majority of gifts flow when the recipient is constrained.[45]

Stage 2 (unilateral house-selling). Given a bargaining outcome $b = [b_i, b_k]$ from the first stage (where b_i denotes the IC arrangement and b_k is an indicator if the house is to be kept under the

[44] We set these bounds as multiples of the receiving agents' incomes in the computations. They only bind within the state space in equilibrium.

[45] However, we find that there are also some positive gifts inside the state space, i.e. when both players have positive wealth. We find this to be the case for very rich dynasties at high ages. These gifts are a very small fraction of all transfers in the economy (less than 0.1%) and play no important economic role. However, it is crucial to allow for them in order for our value-function-iteration algorithm to work.

bargaining arrangement), the Stage-2 value functions are

$$V^{u,2}(z, V_a; y_2, b) = xV^{u,3}([\cdot, a^p + h, \cdot, 0], V_a; y_2, b_i) + (1 - x)V^{u,3}(z, V_a; y_2, b_i)$$
$$\text{for } u \in \{k, p\},$$
$$\text{where } x = \begin{cases} 1 & \text{if } h > 0 \text{ and } b_k = 0 \text{ and} \\ & \mathbb{I}\{V^{p,3}([\cdot, a^p + h, \cdot, 0], \cdot) > V^{p,3}([\cdot, a^p, \cdot, h], \cdot)\}. \\ 0 & \text{otherwise.} \end{cases}$$

This says that parents who are not bound by a bargaining agreement $(b_k = 0)$ decide to sell the house if and only if their value as renters with additional financial wealth h is higher than the value of keeping the house.

Stage 1 (bargaining). Finally, in Stage 1 the parent proposes her preferred arrangement among those that make the child at least indifferent to the outside option. Let s ("strong") denote the index of the player who holds bargaining power and let w ("weak") be the index of the other player; then the bargaining solution satisfies

$$[b^*, Q^*] = \arg\max_{b,Q} V^{2,s}\big(z, V_a; [y_1^k + Q - b_i\beta y(\epsilon^k, j^p), y_1^p - Q], b\big) \tag{11}$$
$$\text{s.t. } b \in \mathcal{B}(z), \qquad Q \in [\bar{Q}_l(z, b), \bar{Q}_u(z, b)],$$
$$V^{2,w}\big(z, V_a; [y_1^k + Q - b_i\beta y(\epsilon^k, j^p), y_1^p - Q], b\big) \geq V^{2,w}\big(z, V_a; [y_1^k, y_1^p], out\big).$$

Note here that the bargaining transfer modifies Stage-2 flow income for both agents, y_2. Also, note that any arrangement involving IC lowers the kid's labor income by $\beta y(\epsilon^k, j^p)$. Finally, given this bargaining outcome the value functions entering Stage 1 are

$$V^u(z) = V^{u,2}\big(z, V_a; [y_1^k + Q^* - b_i^*\beta y(\epsilon^k, j^p), y_1^p - Q^*], b^*\big) \qquad \text{for } u \in \{k, p\}, \tag{12}$$

which completes our recursive characterization of the value functions.

B.3 HJBs and solution of the game

Jump terms. First, we define the jump term $J^u(z)$ to complete the statement of the HJB, Eq. (10):

$$\begin{aligned} J^u(z) = & \underbrace{\delta_s(j^p, \epsilon^p, s)\big[V^u(s=1,\cdot) - V^u(z)\big]}_{\text{shock to health}} + \underbrace{\sum_{\epsilon' \in E} \delta_\epsilon(\epsilon_k, \epsilon') V^u(\cdot, \epsilon') +}_{\text{shock to income}} \\ & + \delta_m(j^p, \epsilon^p, s) \underbrace{\int_0^{\bar{m}} \left(V^u(\max\{a^p - m, 0\}, \cdot) - V^u(z)\right) \mathrm{d}M(m) +}_{\text{medical-spending shock}} \\ & + \underbrace{\delta_d(j^p, \epsilon^p, s)[V^u(a^k + a^p + h, 0, s=2, \epsilon_k, 0, h=0, j^p) - V^u(z)]}_{\text{death}}, \end{aligned} \tag{13}$$

Note here that both the medical-spending and the death shock entail jumps in the asset variables. When the parent dies, her assets (both financial and housing) become zero and are inherited to the child. When a medical shock hits (the lump sum m), the parent's wealth falls by m, but not below zero.

Indirect utility function. The FOCs for a renter with respect to consumption, c, and housing, h, given total expenditures e in the Problems (5) and (6) are

$$c = \xi e, \qquad\qquad x = (1-\xi)\frac{e}{r+\delta}.$$

Thus, the Cobb-Douglas aggregate for a renter is given by

$$c^\xi x^{1-\xi} = \xi^\xi e^\xi \left(\frac{1-\xi}{r+\delta}\right)^{1-\xi} e^{1-\xi} = \xi^\xi \left(\frac{1-\xi}{r+\delta}\right)^{1-\xi} e,$$

which is homogeneous of degree one in e. For a homeowner, the house size is pre-determined and so the solution to the intra-temporal problem is simply to set $c = e - \delta h$ and the aggregate becomes

$$c^\xi x^{1-\xi} = (\omega h)^{1-\xi} \tilde{e}^\xi,$$

which is homogeneous of degree ξ in after-housing-depreciation expenditures $\tilde{e} \equiv e - \delta h$. Flow utility for a renter household is then given by

$$u(c, x; n, 0) = \underbrace{n\left(\left(\frac{\xi^\xi}{\phi(n)}\right)\left(\frac{1-\xi}{r+\delta}\right)^{1-\xi}\right)^{1-\gamma}}_{\equiv A(n,0)} \frac{e^{1-\gamma}}{1-\gamma},$$

where we have introduced the utility shifter $A(\cdot)$, which we will also define for owners now. For a homeowner optimal expenditure yields utility

$$u(c, x; n, h) = \underbrace{n\xi \left(\frac{(\omega h)^{(1-\xi)}}{\phi(n)}\right)^{1-\gamma}}_{\equiv A(n,h),\text{ for } h>0} \frac{\tilde{e}^{\xi(1-\gamma)}}{\xi(1-\gamma)}.$$

Upon substituting optimal expenditure we obtain the indirect felicity function

$$\tilde{u}(e; n, h) = \begin{cases} A(n,0)\frac{e^{1-\gamma}}{1-\gamma} & \text{if } h = 0 \text{ (renter)}, \\ A(n,h)\frac{\tilde{e}^{\xi(1-\gamma)}}{\xi(1-\gamma)} & \text{if } h > 0 \text{ (owner)}. \end{cases} \tag{14}$$

Consumption. As has been discussed in our previous work, the determination of expenditure is straightforward despite the fact that game-theoretic considerations are present; this occurs since consumption expenditures of the other player over a short horizon have a negligible impact on the asset stock and thus affect the marginal value of savings only to a second order. The FOC which determines optimal expenditure e^j of player j is

$$\tilde{u}_e(e^j; n, h) \geq V^j_{a^j} \quad \text{with equality if unconstrained,} \tag{15}$$

where $\tilde{u}$ is given by Equation (14) and $\tilde{u}_e$ denotes the partial derivative with respect to e^j.

Medicaid. The Medicaid decision is solved for in the same way as in Barczyk & Kredler (2018), see Section 2.1.2 of their online appendix for the details.

Notation and auxiliary gift variables. Before discussing the optimal gift-giving choices and the bargaining outcome, it is useful to establish some notation. First, the "diagonal derivatives" of players' value functions are key for transfer decisions; we will use these derivatives repeatedly in this section. Define player u's diagonal derivative as

$$\mu^u(z) \equiv V^u_{a^{-u}}(z) - V^u_{a^u}(z). \tag{16}$$

In order to determine equilibrium gifts, we make use of auxiliary gift variables, which arise in variations of our setting that we describe now. Fix state $z = (a^k, a^p, s, y^k, y^p, h)$ and assume that either the child is broke, $a^k = 0$, or the parent is broke, $a^p = 0$. Define agents' *unconstrained consumption* as the levels of consumption they would choose if facing no borrowing constraints, i.e. define them implicitly as the solution to the consumption first-order condition (FOC)

$$u_c^k(c_{unc}^k(z)) = V_{a^k}^k(z), \qquad u_c^p(c_{unc}^p(z)) = V_{a^p}^p(z). \tag{17}$$

We will drop the conditioning of c_{unc}^i and other variables on z from now on for better readability.

Consider the following two *dictator* problems. Let variables with a prime refer to the broke agent, e.g. $a' = 0$:

$$\max_{c\geq 0, c'\geq 0} \{u(c) + \alpha u(c') + (ra + y + y' - c - c')V_a\}, \tag{18}$$

$$\max_{c\geq 0, g} \{u(c) + \alpha u(c'(g)) + (ra + y - g - c)V_a + (y' + g - c'(g))V_{a'}\}, \tag{19}$$

$$\text{where} \quad c'(g) = \min\{y' + g, c'_{unc}\},$$

where we assume $V_a > V_{a'}$ and where $u(\cdot)$ is a utility function satisfying $u' > 0$, $u'' < 0$, and Inada conditions. In the first problem, the dictator agent can directly set the broke agent's consumption. In the second problem, the dictator agent sets a (possibly negative) transfer and the broke agent's consumption then realizes from the broke agent's optimal decision given the unconstrained consumption level, c'_{unc}. We now define two *desired consumption* levels from these problems: Let $\tilde{c}^p$ denote the parent's consumption if the kid could dictate it and let $\tilde{c}^k$ denote kid's consumption if the parent could dictate it. Formally, $\tilde{c}^p$ and $\tilde{c}^k$ are implicitly defined from the FOCs for Problem (18):

$$\alpha^p u_c^k(\tilde{c}^k) = u_c^p(c_{unc}^p), \qquad \alpha^k u_c^p(\tilde{c}^p) = u_c^k(c_{unc}^k). \tag{20}$$

We will call the transfer associated with this consumption level the *first-best transfer* in the gift-giving game; the values $g_{f.b.}^p \in (-\infty, \infty)$ and $g_{f.b.}^k \in (-\infty, \infty)$ are defined as

$$g_{f.b.}^p = \tilde{c}^k - y^k, \qquad g_{f.b.}^k = \tilde{c}^p - y^p. \tag{21}$$

It is important to note that these first-best transfers can be *negative*. In the second dictator problem, Problem (19), this transfer is also optimal, unless the broke agents starts to save some of the transfer. We define the *second-best transfer* as the solution to this problem, which is:

$$g_{s.b.}^p = \min\{g_{f.b.}^p, c_{unc}^k - y^k\}, \qquad g_{s.b.}^k = \min\{g_{f.b.}^p, c_{unc}^p - y^p\}. \tag{22}$$

For the case in which both agents are broke, we will also make use of *static* first- and second-best transfers, which arise in a static gift-giving setting. They are defined implicitly as the numbers

$g^p_{stat,f.b.} \in (-\infty, \infty)$ and $g^k_{stat,f.b.} \in (-\infty, \infty)$ that solve the gift-giving FOCs

$$u^p_c(y^p - g^p_{stat,f.b.}) = \alpha^p u^k(y^k + g^p_{stat,f.b.}), \tag{23}$$
$$u^k_c(y^k - g^k_{stat,f.b.}) = \alpha^k u^p(y^p + g^k_{stat,f.b.}), \tag{24}$$

Analogously to before, we define the second-best static transfer as the gift that arises when the transfer recipient decides on savings:

$$g^p_{stat,s.b.} = \min\{g^p_{stat,f.b.}, c^k_{unc} - y^k\}, \qquad g^k_{stat,s.b.} = \min\{g^p_{stat,f.b.}, c^p_{unc} - y^p\}. \tag{25}$$

Gift-giving. For optimal gift-giving, we have to distinguish if players are broke or not. In the following, only Case 1. (no agent broke) is new with respect to our previous work since we have to solve for gifts within the state space. In Cases 2.-4. (at least one agent broke), the solution from Barczyk & Kredler (2014, QE) applies; we only state the solutions here and refer the reader there for details.[46]

1. No agent broke: $a^p > 0$ and $a^k > 0$. In this case, agents' diagonal derivatives $\mu^u(z)$. It is obvious from Eq. (10) that the gift is either set to the upper or the lower bound:
   (a) $\mu^u(z) \geq 0$: The optimal gift choice is to set gifts as high as possible, i.e. $g^u(z) = \bar{T}_u(z)$.
   (b) $\mu^u(z) \leq 0$: This is the more common case, in which the agent prefers to hold on to own wealth and thus sets $g^u(z) = 0$.
2. Only kid broke: $a^p > 0$ and $a^k = 0$. The solution is $g^p(z) = \max\{0, g^p_{s.b.}(z)\}$ and $g^k(z) = 0$.
3. Only parent broke: $a^p = 0$ and $a^k > 0$. The solution is $g^p(z) = 0$ and $g^k(z) = \max\{0, g^k_{s.b.}(z)\}$.
4. Both agents broke: $a^p = a^k = 0$. Then the following cases can be distinguished (note that (a) and (b) can be shown to be mutually exclusive):
   (a) If $g^p_{stat,f.b.}(z) > 0$, then the solution is $g^p(z) = g^p_{stat,s.b.}(z)$ and $q^k(z) = 0$.
   (b) If $g^k_{stat,f.b.}(z) > 0$, then the solution is $g^p(z) = 0$ and $g^k(z) = g^k_{stat,s.b.}(z)$.
   (c) Otherwise, no gifts flow: $g^p(z) = g^k(z) = 0$.

[46] If the parent chooses Medicaid in the ensuing stage, also the threshold gift at which the parent stays out of Medicaid has to be taken into account. We follow Barczyk & Kredler (2018) to do this and refer the reader to their paper for details.

Bargaining. In order to reduce the set of inside options to one element for all scenarios, we will first show that for disabled homeowners, we can drop the inside option *sell+IC* from the bargaining set. It turns out that the option *sell+IC* is irrelevant since its outcome is equivalent to when the house is sold under the outside option. Technically, this is due to the continuous-time setup and the no-commitment assumption. The intuition for the result is very simple: There is no commitment to what happens after the house is sold, thus the care choice will immediately switch to whatever is the bargaining outcome that prevails for renting families (at the state that the family ends up in).

Proposition 1 (Irrelevance of inside option *IC+sell*) *Consider an allocation $\mathcal{A}$ and an alternative allocation $\mathcal{A}'$ that is equal to $\mathcal{A}$, but for which we replace the bargaining outcome $(sell, IC)$ by the outside option being played and the parent selling the house (i.e. $x = 1$). $\mathcal{A}$ and $\mathcal{A}'$ are equivalent in the sense that*

1. *both players' value functions are the same under the two allocations,*
2. *both are an equilibrium, and*
3. *for a given realization of a shock history, the allocation (care, consumption, gifts etc.) for almost all t (i.e. except a set of Lebesgue-measure zero).*

Proof: In any state $z = (\cdot, a_t^p, h_t, t)$ in which the inside option (sell,IC) is played in allocation $\mathcal{A}$, the value for agent $j \in \{p, k\}$ is

$$V^j_{sell,IC}(\cdot, a_t^p, h, t; Q) = U^j_{sell,IC}(\cdot)dt + e^{-\rho dt}\mathbb{E}_{t,Q}\big[V^j(\cdot, a^p_{t+dt}, h = 0, t + dt)\big],$$

where $U^j_{sell,IC}(\cdot)$ is agent j's flow utility under option (sell,IC) and where $\mathbb{E}_{t,Q}$ is the conditional expectation given the equilibrium transfers Q. As we let $dt \to 0$, this converges to the value of renting, i.e.

$$\lim_{dt\to 0} V^j_{sell,IC}(\cdot, a^p, h, t; Q) = V^j(\cdot, a^p + h, h = 0, t), \tag{26}$$

where $V^j(\cdot, a^p + h, 0, t)$ is entirely determined by whichever care choice (IC or FC) is played in equilibrium at point $z' = (\cdot, a^p + h, h = 0)$; we note that this occurs since players cannot commit to future bargaining outcomes. The value under allocation $\mathcal{A}'$ is equal to the value under $\mathcal{A}$, by the same argument. Since all other elements of the two allocations are the same, the first claim of the proposition follows.

The second claim then follows immediately: Since players are indifferent between allocations $\mathcal{A}$ and $\mathcal{A}'$, replacing one choice by the other has the same value, thus it must also be a bargaining solution.

After the house is sold, IC is only given for an infinitesimal amount of time $\mathrm{d}t$, before the family reverts to the bargaining solution for IC, $i(\cdot, a_h^p, h = 0, t)$, that prevails under renting. Letting $\mathrm{d}t \to 0$, we see that the third claim of the proposition follows. ■

We now turn to the question if the inside option is played and if so, which transfer Q is given in equilibrium. It turns out that it is fruitful to think about the gift-giving and bargaining stages jointly, since both of them involve monetary transfers that may net out. Our first task will be to solve for the equilibrium of the gift-giving sub-game (Stage 3) for any conceivable transfer $Q \in (-\infty, \infty)$ in the bargaining stage; we will impose the feasibility bounds for the different inside options later in order to have a unified treatment here, i.e. we will aim for solving the gift-giving game for all possible combinations in the Stage-3 income vector y_3. It turns out that a simplification will arise since both agents are altruistic: Transfers of large absolute magnitude will often be returned – or *undone*, at least partly – by the recipient in the gift-giving stage if the transfer goes beyond a level of consumption inequality that is tolerated by the recipient.

We start with the most complicated case, which is when both players are broke. The following proposition gives us the transfer Q that each of the agents would prefer to see in the bargaining stage in this situation; this number will be key to characterize the best responses in the gift-giving game.

Lemma 1 (Bliss points of gift-giving game when both agents are broke.) *Fix a state $z = (a^k, a^p, \dots)$ such that $a^k = a^p = 0$, $\mu^k(z) < 0$, and $\mu^p(z) < 0$. Then any $Q \in (-\infty, Q^p_{bliss}(z)]$, where*

$$Q^p_{bliss}(z) = \min\left\{g^p_{s.b.}(z), g^p_{stat,f.b.}(z)\right\}$$

attains the maximum in the problem

$$\max_{Q\in(-\infty,\infty)} H^{p,3}\big(z, V_a; [y^k + Q, y^p - Q], i\big),$$

i.e. any transfer $Q \leq Q^p_{bliss}(z)$ in the bargaining stage induces the globally preferred allocation for the parent going into the gift-giving stage at z. Similarly, any $Q \in [Q^k_{bliss}(z), \infty)$, where

$$Q^k_{bliss}(z) = -\min\{g^k_{s.b.}(z), g^k_{stat,f.b.}(z)\},$$

attains the maximum in the child's value going into the gift-giving stage, i.e.

$$\max_{Q\in(-\infty,\infty)} H^{k,3}(z, V_a; [y^k + Q, y^p - Q], i).$$

Proof: We will only show the statement for Q^p_{bliss}; the argument for Q^k_{bliss} is exactly the same, making the obvious adjustments. Note that to find the parent's preferred allocation in the gift-giving stage, it is sufficient to consider the situation in which the parent has ownership of all of the family's flow income, $y^p + y^k$, since this gives the parent the possibility to induce any split of resources in the transfer stage. The parent's problem in the gift-giving stage, when endowed with all of family income, is

$$\max_{c^p, g^p} \Big\{ u^p(c^p) + \alpha^p u^k(\min\{g^p, c^k_{unc}\}) + \max\{g^p - c^k_{unc}, 0\} V^p_{a^k} - [c^p + g^p] V^p_{a^p} \Big\},$$
$$\text{s.t. } c^p + g^p \leq y^p + y^k, \qquad c^p \geq 0, \qquad g^p \geq 0.$$

By the Inada conditions on $u^p(\cdot)$ and $u^k(\cdot)$, the non-negativity constraints on c^p and g^p will never bind. Also, since $V^p_{a^p} > V^p_{a^k}$ (by the assumption $\mu^p < 0$), the parent will never give a gift that goes into the child's savings. Thus we can re-write the problem as

$$\max_{c^p, g^p} \Big\{ u^p(c^p) + \alpha^p u^k(g^p) - [c^p + g^p] V^p_{a^p} \Big\}, \tag{27}$$

$$\text{s.t. } c^p + g^p \leq y^p + y^k, \tag{28}$$

$$g^p \leq c^k_{unc}. \tag{29}$$

Putting Lagrange multipliers λ_1 and λ_2 on the two constraints, the FOCs for this problem are

$$u^p_c(c^p) = V^p_{a^p} + \lambda_1,$$
$$\alpha^p u^k_c(g^p) = V^p_{a^p} + \lambda_1 + \lambda_2.$$

Taking the two FOCs together, we have

$$u^p_c(c^p) + \lambda_2 = \alpha^p u^k_c(g^p),$$

From this equation, together with the budget constraint (28), we can construct a function that tells us what the gift has to be in the optimum given a guess c^p for the parent's consumption. We define

$$\hat{g}^p(c^p) = \min\Big\{ \hat{c}^k(c^p), c^k_{unc} \Big\},$$
$$\text{where } \hat{c}^k(c^p) = (u^k_c)^{-1}\big(u^p_c(c^p)/\alpha^p\big).$$

In words, the function $\hat{g}^p(c^p)$ is such that it sets (altruistic) marginal utility that the parent derives from her kid's consumption equal to the marginal utility of the parent's own consumption as long as the child doesn't save. Once the child saves additional transfers $\hat{g}^p(c^p)$ stays flat. We note that $\hat{c}(\cdot)$ is an increasing function: The higher c^p, the lower marginal utility u^p_c, and the higher $\hat{c}^k$ (since u^k_c is a decreasing function). This implies that $\hat{g}^p(\cdot)$ is a weakly increasing function in c^p.

Now, we can re-write the parent's problem from (27) in just one choice variable:

$$\max_{c^p}\Big\{u^p(c^p)+\alpha^p u^k\big(\hat{g}^p(c^p)\big)-\big[c^p+\hat{g}(c^p)\big]V^p_{a^p}\Big\},$$
$$\text{s.t. } c^p+\hat{g}^p(c^p)\le y^p+y^k.$$

We see that there is a maximal consumption choice c^p_{max} that makes the constraint of this problem being binding, which is associated with a gift choice $g^p=\hat{g}^p(c^p)=\min\{g^p_{stat,f.b.},c^k_{unc}\}$. Clearly, if and only if $c^p_{unc}<c^p_{max}$ we have an interior solution with optimal transfer $g^p=\hat{g}^p(c^p_{unc})=g^p_{s.b.}=\min\{\tilde{c}^k,c^k_{unc}\}$. Otherwise, the constraint must bind and the parent's preferred transfer is $g^p_{stat,s.b.}=\min\{g^p_{stat,f.b.},c^k_{unc}\}$. This establishes that the optimal transfer is $g^*=\min\{g^p_{s.b.},g^p_{stat,f.b.}\}$; Note that if $g^p_{stat,f.b.}$ is such that it goes into savings of the child, then the min-operator will pick up c^k_{unc} in the expression for $g^p_{s.b.}$ in Eq. (22).

Finally, note that any transfer Q in the bargaining stage that gives the parent a Stage-3 income of $y^p_3\ge y_p-g^*$ (i.e. a higher share of resources than under the parent's optimum) will allow the parent to attain her preferred allocation and is thus equivalent, as the Proposition claims. ■

With this in place, we now turn to the more general problem when at least one of the players is broke. It turns out that there are threshold transfers in the bargaining stage beyond which one of the agents returns part of the transfer by giving altruistic gifts:

Lemma 2 (Indifference thresholds Q^*_l and Q^*_u) *Fix state $z=(a^k,a^p,s,y^k,y^p,h)$ and assume that either the child is broke, $a^k=0$, or the parent is broke, $a^p=0$, or both. Furthermore, assume that $\mu^p(z)<0$ and $\mu^k(z)<0$. Define the* lower indifference threshold *as*

$$Q^*_l(z)=\begin{cases}\min\{g^p_{stat,f.b.}(z),g^p_{s.b.}(z)\} & \textit{if } a^k=0,a^p=0,\\ g^p_{s.b.}(z) & \textit{if } a^k=0,a^p>0,\\ -\infty & \textit{if } a^k>0,\, a^p=0,\end{cases}\tag{30}$$

and define the upper indifference threshold *as*

$$Q^*_u(z)=\begin{cases}-\min\{g^k_{stat,f.b.}(z),g^k_{s.b.}(z)\} & \textit{if } a^p=0,a^k=0,\\ -g^k_{s.b.}(z) & \textit{if } a^p=0,a^k>0\\ \infty & \textit{if } a^p>0,\, a^k=0,\end{cases}\tag{31}$$

where $\{g^i_{s.b.},g^i_{stat,f.b.}\}_{i\in\{k,p\}}$ are defined by Equations (22) *and* (25)*. Then:*

1. *Both agents are indifferent among all bargaining transfers exceeding these thresholds, that*

is

$$V^{i,2}(z; y^k + Q, y^p - Q,) = V^{i,2}(z; y^k + Q_l^*, y^p - Q_l^*) \qquad \forall Q \in (-\infty, Q_l^*],\ i = k, p;$$
$$V^{i,2}(z; y^k + Q, y^p - Q) = V^{i,2}(z; y^k + Q_u^*, y^p - Q_u^*) \qquad \forall Q \in [Q_l^*, \infty),\ i = k, p;$$

where $V^{i,2}(z; \tilde{y})$ is agent i's value function in the gift-giving stage for state z and post-bargaining flow income vector $\tilde{y}$.

2. $Q_l^*(z) \leq Q_u^*(z)$.

3. *The parent's surplus is strictly decreasing and the kid's surplus is strictly increasing in Q on the interval $[Q_l^*(z), Q_u^*(z)]$.*

Proof:

1. **Only the child is broke ($a^k = 0$, $a^p > 0$):**

   (a) *Lower indifference bound*: It is clear from the definition of $g^p_{s.b.}$ that any transfer Q satisfying $Q < g^p_{s.b.}$ would be topped up to $g^p_{s.b.}$ by the parent in the gift-giving stage, i.e. the parent would choose $g^p = g^p_{s.b.} - Q$, which implements her preferred allocation among all feasible allocations over a short interval $\mathrm{d}t$. This shows that both agents are indifferent among the transfer Q and $Q_l^* = g^p_{s.b.}$ since they induce the same allocation.

   (b) *Upper indifference bound*: Since $a^p > 0$ and $\mu^p < 0$, there will never be gifts from child to parent in the gift-giving stage. Since $\mu^k < 0$, the child's surplus is strictly increasing in Q for all Q and thus $Q_u^* = \infty$, as claimed in Point 1 of the Proposition.

We have thus shown Point 1 for the case in which only the child is broke. Point 2 also obviously holds. We now turn to Point 3. Denote by Q_{thr} the threshold transfer at which the child starts to save the additional transfer unit. We have $Q_{thr} \geq Q_l^*$ by construction of Q_l^* (the parent never gives gifts that flow into the child's savings since $\mu^p < 0$). Now, the child's surplus is strictly increasing for $Q \in (Q_l^*, Q_{thr})$ since $u_c^k(y^k + Q) \geq V^k_{a_k} > V^k_{a^k}$, where the first inequality follows from the child's optimal consumption choice and the second follows from $\mu^k < 0$. For $Q \in [Q_{thr}, Q_u^*)$, the kid's surplus is also strictly decreasing since $V^k_{a_k} > V^p_{a^p}$ by $\mu^k < 0$. Similarly, the parent's surplus is strictly decreasing for $Q \in (Q_l^*, Q_{thr})$ since $\alpha^p u_c^k(y^k + Q) < \alpha^p u_c^k(y^k + Q_l^*) = V^p_{a^p}$, which follows from the optimal choice of gifts by the parent and decreasingness of marginal utility. Finally, for $Q \in [Q_{thr}, Q_u^*)$, the parent's surplus is also decreasing, since $V^p_{a^k} < V^p_{a^p}$ by $\mu^p < 0$. This completes the proof of Point 3 of the Proposition for Case 1 (only child broke).

2. **Only the parent is broke ($a^k > 0$, $a^p = 0$):**

   This case is analogous to the Case 1 in which only the kid is broke. However, since Q is a net transfer from parent to child, we have to switch the signs for the net transfers Q, and also the role of the two agents in the upper and lower bounds is reversed.

3. **Both agents are broke, $a^k = a^p = 0$.**

   The indifference bounds Q_l^* and Q_u^* in Point 1 of the proposition follow immediately from Lemma 1. As for the ordering of Q_l^* and Q_u^*, note first that imperfect altruism ($\alpha^p\alpha^k \leq 1$) implies that $g^p_{stat,f.b.} \leq -g^k_{stat,f.b.}$, i.e. the kid would always make the parent give a larger net transfer than the parent herself would. Also, by Lemma 1, we have $Q_l^* = \min\{g^p_{stat,f.b.}, g^p_{s.b.}\}$ and $Q_u^* = -\min\{g^k_{stat,f.b.}, g^k_{s.b.}\}$. These together imply the ordering $Q_l^* \leq g^p_{stat,f.b.} \leq -g^k_{stat,f.b.} \leq Q_u^*$, which finishes the proof of Point 2 in the Proposition. Finally, Point 3 also holds obviously in this final case by an argument analogous to the case in which only the child is broke. ■

With these indifference bounds for the constrained case in place, we can now widen the scope of the analysis. We will now also include the case in which both agents have wealth. Here, especially the case in which one of the diagonal derivatives is positive, i.e. $\mu^p \geq 0$ or $\mu^k \geq 0$, is of interest. Furthermore, recall that the indifference bounds $\{Q_l^*, Q_u^*\}$ were defined on the entire real line, while in practice we impose exogenous bounds $\{\bar{Q}^l, \bar{Q}^u\}$ on them. We will now bring all elements together by defining the set $[Q_{lb}(z), Q_{ub}(z)]$ of bargaining transfers that we have to consider at state z in our analysis:

$$Q_{lb}(z) = \begin{cases} \bar{Q}_l(z) & \text{if } a_p > 0 \text{ and } \mu^p(z) < 0, \\ \bar{Q}_u(z) & \text{if } a_p > 0 \text{ and } \mu^p(z) \geq 0, , \\ \min\left\{\bar{Q}_u(z), \max\{\bar{Q}_l(z), Q_l^*(z)\}\right\} & \text{otherwise,} \end{cases} \tag{32}$$

$$Q_{ub}(z) = \begin{cases} \bar{Q}_u(z) & \text{if } a_k > 0 \text{ and } \mu^k(z) < 0, \\ \bar{Q}_l(z) & \text{if } a_k > 0 \text{ and } \mu^k(z) \geq 0, \\ \min\left\{\bar{Q}_u(z), \max\{\bar{Q}_l(z), Q_u^*(z)\}\right\} & \text{otherwise.} \end{cases} \tag{33}$$

Some notes are in order on these definitions. If, for example, we are on the interior of the state space ($a^p > 0$, $a^k > 0$) and each player prefers to hold on to their wealth ($\mu^p < 0$ and $\mu^k < 0$), then we have consider the entire set of feasible transfers, $[\bar{Q}_l, \bar{Q}_u]$. If, however, the parent has a non-negative diagonal derivative ($\mu^p \geq 0$) but the situation is otherwise unchanged, then the interval $[Q_{lb}, Q_{ub}]$ collapses to the point $\bar{Q}_u$. In this case, the parent wants to transfer wealth to the child and the child is OK with this; thus we only consider the highest possible transfer from the feasible since this is the best outcome for each of the players and thus the only candidate for a bargaining solution. Similarly, interests are aligned if the child wants to transfer wealth to the parent and we only consider the transfer $\bar{Q}_l$.[47] Finally, when an agent is broke, we use the indifference bounds established in Lemma 2, since we need not consider transfers that are returned by one of the agents in the gift-giving stage. For example, when both agents are broke, we consider all feasible transfers from the range $[\bar{Q}_l, \bar{Q}_u]$ that do not lie beyond the bliss points Q_l^* and Q_u^*.

By construction, on the interval $Q \in [Q_{lb}, Q_{ub}]$ the kid's surplus is strictly increasing and the parent's surplus is strictly decreasing.[48] This allows us to define the *reservation transfer*, i.e. the lowest transfer for which an agent is willing to consider the inside option[49] over the outside option in state z, as

$$\underline{Q}^k(z) = \begin{cases} \infty & \text{if } S^k(z, Q_{ub}(z)) \leq 0 \\ Q_{lb}(z) & \text{if } S^k(z, Q_{lb}(z)) \geq 0, \\ \arg\min_{Q \in (Q_{lb}(z), Q_{ub}(z))} |S^k(z, Q)| & \text{otherwise,} \end{cases} \tag{34}$$

$$\underline{Q}^p(z) = \begin{cases} -\infty & \text{if } S^p(z, Q_{lb}(z)) \leq 0 \\ Q_{ub}(z) & \text{if } S^p(z, Q_{ub}(z)) \geq 0, \\ \arg\min_{Q \in (Q_{lb}(z), Q_{ub}(z))} |S^p(z, Q)| & \text{otherwise,} \end{cases} \tag{35}$$

where $S^u(z, Q)$ denotes agent u's surplus of the inside over the outside option under transfer Q. We now go over the different cases in this definition; we do so for both Eq. (34) and (35) jointly. In the first case, the agent prefers the outside option even under the most favorable Q that we need to consider, thus a (finite) reservation transfer does not exist and there will be no bargaining solution. The second case is the one in which the agent already prefers the inside option under the least favorable Q from the set that we have to consider. In all other cases, it must be possible to find a reservation transfer between the worst- and best-possible transfer that makes the agent indifferent between the two options.

In all other cases, we find $\underline{Q}^w$ numerically for the weak party w by a root-finding routine.

Finally, we define $\bar{S}^u$ as the highest surplus that agent agent u can obtain from the set of

[47] There is a pathological case in which *both* players want to transfer wealth to the other ($\mu^p \geq 0$, $\mu^k \geq 0$). In this case, we assign a net transfer Q in an ad-hoc fashion as it is described for the case of gift-giving in Section E.1.

[48] We have already shown this for the case in which one of the agents is broke, see Lemma 2. For the case in which both players have positive, wealth, both players' surplus is clearly monotone when diagonal derivatives are negative; in the other cases the interval collapses to a point.

[49] Recall that by Prop. 1, there is only one inside option left for each bargaining scenario.

transfers Q that induce the other agent to prefer the inside option over the outside option:

$$\bar{S}^p(z) = \begin{cases} -\infty & \text{if } S^k(z, Q_{ub}(z)) < 0 \text{ or } S^p(z, Q_{lb}(z)) < 0 \\ S^p(z, \underline{Q}^k(z)) & \text{otherwise,} \end{cases} \tag{36}$$

$$\bar{S}^k(z) = \begin{cases} -\infty & \text{if } S^k(z, Q_{ub}(z)) < 0 \text{ or } S^p(z, Q_{lb}(z)) < 0 \\ S^k(z, \underline{Q}^p(z)) & \text{otherwise.} \end{cases} \tag{37}$$

Here, we have assigned $-\infty$ for the cases in which the bliss point is undesirable for one of the agents since then no bargain is possible. Note that for the special case in which both players own wealth and one diagonal derivative is positive, the bounds $Q_{lb} = Q_{ub}$ coincide and $\bar{S}^k$ and $\bar{S}^p$ are positive if and only if both players prefer the inside option under the prescribed transfer.

Finally, since the parent has all bargaining power, we only have to compare the values for $\bar{S}^p$ to find the bargaining outcome. The following proposition summarizes the solution; the proof then goes over all cases again and gives our solution algorithm:

Proposition 2 (Bargaining solution) *Let the inside option be* keep *for healthy homeowners,* IC *for disabled renters, and* keep+IC *for disabled home owners; let s index the party with bargaining power and let w index the party without. Then, if $\bar{S}^s(z) \geq 0$, the inside option is played and the equilibrium transfer is $\underline{Q}^w(z)$. Otherwise, the outside option is played.*

Proof and solution algorithm: First, we note that by Proposition 1, we only have to consider the inside option *IC+keep* for disabled owners, which justifies restricting ourselves to the inside options mentioned in the proposition.

We now go over the list of possible cases and show how we resolve them.

1. $a^p > 0$ and $a^k > 0$ (both agents have wealth):

   (a) $\mu^p(z) < 0$ and $\mu^k(z) < 0$ (both prefer own wealth): This is the common case. By setting agents' surplus under the inside option to zero, we can calculate a candidate for the weak party's reservation transfers – this is only a candidate, since we neglect the exogenous bounds for transfers here:

   $$\tilde{Q}^w(z) = \frac{V^{w,in,0}(z) - V^{w,out}(z)}{\mu^w(z)\Delta t} \qquad \text{if } a^k > 0, a^p > 0, \mu^w(z) < 0,$$

   where $V^{w,in,0}$ is player w's value under the inside option and a zero transfer (i.e. $Q = 0$). If $w = k$ and $\tilde{Q}^k(z) > \bar{Q}_u$ or $w = p$ and $\tilde{Q}^p(z) < \bar{Q}_l$, then the outside option is played since no admissible transfer gives positive surplus for the weak party.

Otherwise, we can find the reservation transfer as

$$\underline{Q}^k(z) = \max\{\tilde{Q}^k(z), \bar{Q}_l\},$$
$$\underline{Q}^p(z) = \min\{\tilde{Q}^p(z), \bar{Q}_u\},$$

where the max-min operators take care of the case in which the weak party already prefers the inside option under the least favorable transfer. The inside option is then played iff the strong party's surplus given this reservation transfer is positive.

(b) Otherwise ($\mu^p(z) \geq 0$ or $\mu^k(z) \geq 0$): If the parent prefers the kid to have wealth, the candidate set collapses to $[Q_{lb}(z), Q_{ub}] = [\bar{Q}_u, \bar{Q}_u]$, see Eq. (32) and (33), and the inside option is played iff both agents prefer the inside option and this transfer to the outside option. If the kid prefers the parent to have wealth, the candidate set collapses to $\bar{Q}_l$ and bargaining outcome is obtained in the same fashion. In the pathological case in which both $\mu^p \geq \mu^k$ we obtain a candidate transfer taking into account the relative strength of agents' transfer motives in the same way we treat altruistic transfers; see the Computational Appendix E.1.

Clearly, under the inside option both agents' gifts are zero and consumption is equal to the unconstrained levels, c^p_{unc} and c^k_{unc}.

2. $a^p = 0$ or $a^k = 0$ or both (at least one agent broke): The first step is to obtain the indifference thresholds Q^*_l and Q^*_u from Lemma 2. Then, there are two cases to consider: (a) the intervals (Q^*_l, Q^*_u) and $(\bar{Q}_l, \bar{Q}_u)$ do not overlap or (b) the intervals do overlap.

   (a) The intervals (Q^*_l, Q^*_u) and $(\bar{Q}_l, \bar{Q}_u)$ do not overlap. This case can again be sub-divided in:

      i. $Q^*_l \geq \bar{Q}_u$: The parent undoes any admissible Q and tops them up with gifts in the gift-giving stage.[50] We only have to evaluate the transfer $Q = \bar{Q}_u$, since all other transfers lead to the same allocation. A bargaining solution with transfer $\bar{Q}_u$ is obtained iff both players prefer this outcome to the outside option. The parent then gives a positive gift in the gift-giving stage.

      ii. $Q^*_u \leq \bar{Q}_l$: The child undoes any admissible Q and tops it up with gifts in the gift-giving stage.[51] We only have to evaluate the transfer $Q = \bar{Q}_l$. A bargaining solution with transfer $\bar{Q}_l$ is obtained iff both players prefer this outcome to the outside option. The kid then gives a positive gift in the gift-giving stage.

[50] This case can occur for for healthy, house-owning parents ($\bar{Q}_u = 0$) who want to give gifts to their kids.

[51] This case can occur for disabled renting parents ($\bar{Q}_l = 0$) when a rich child wants to give altruistic transfer to them under the inside option IC ($g^k_{s.b.} \geq 0$).

(b) The intervals (Q_l^*, Q_u^*) and $(\bar{Q}_l, \bar{Q}_u)$ overlap. In this case we have to look for the equilibrium transfer on the overlap $[Q_{lb}, Q_{ub}]$, see Eq. (32) and (33). The cases to consider are:

i. Bliss points undesirable: $S^p(Q_{lb}) < 0$ or $S^k(Q_{ub}) < 0$. If at least one agent cannot be made better of (even under the most favorable transfer for them), then we assign $\bar{S}^{p,i} = -\infty$ since the outside option is preferred, see Eq. (36) and (37). The outside option is played.

ii. Otherwise (bliss points desirable), we have to find the weak party's reservation transfer. There are two cases to consider:

A. If the weak party already accepts the least generous offer, then this least generous offer is the candidate transfer for a bargaining solution. (i) When the child is the weak party, this requires $S^k(Q_{lb}) \geq 0$ and the candidate is $Q^* = Q_{lb}$. (ii) When the parent is the weak party, this requires $S^p(Q_{ub}) \geq 0$ and the candidate is $Q^* = Q_{ub}$.

B. Otherwise: We find the weak party's reservation transfer as the $Q^* \in (Q_{lb}, Q_{ub})$ that solves $S^w(Q^*) = 0$ by a root-finding algorithm.[52]

Then, for both A. and B., obtain the strong party's surplus under the reservation transfer, i.e. assign $\bar{S}^s = S^s(\underline{Q}^*)$.The inside option with transfer Q^* is played iff $\bar{S}^s \geq 0$.

Checking the formulae (34)-(37) for all cases shows the desired result. ■

[52]Note that on the interval (Q_{lb}, Q_{ub}), by construction there are no gifts in the gift-giving stage and we can restrict ourselves to computing consumption according to a simple rule: Broke agents consume all transfers until they reach their unconstrained consumption level, c_{unc}^u; agents with wealth always consume c_{unc}^u. The surplus can then be evaluated at a low computational cost by varying the flow utility term and the savings terms in the HJB (savings terms are terms in $V_{a^u}^u$ and $V_{a^{-u}}^u$)).

Supplemental Appendix to “Save, Spend, or Give? A Model of Housing, Family Insurance, and Savings in Old Age”

by Daniel Barczyk, Sean Fahle, and Matthias Kredler

C Estate value imputation procedure

As is typical in surveys where dollar amounts are concerned, there are numerous cases in our data where the precise dollar value of the decedent’s estate is unknown. In this section, we describe the procedure we use to impute estate values for these cases. We first document the extent and varieties of missing data in our sample. We then describe the imputation procedure in detail. Finally, we discuss how we deal with an added complication in our imputation procedure which concerns whether the reported estate value includes (and whether it *should* include) the primary residence or not.

C.1 Missing estate values

Table OA2 reports the types and frequencies of estate value reports in our final sample of single decedents. *No asset* means the decedent left no bequest, which is the case for 1,168 decedents in our sample (38.68%). *Continuous report* refers to cases in which the proxy respondent reported the dollar amount of the estate. This applies to 1,836 individuals, accounting for 36.29% of the sample or just under 60% of those known to have left a bequest. When a proxy was unable or unwilling to report a precise dollar value for the estate, the HRS survey attempted to elicit bounds on the estate value using an HRS innovation known as “unfolding brackets.” In this procedure, the interviewer cycles through a sequence of pre-defined “breakpoints” (i.e., the endpoint of the bracket intervals) and asks the respondent whether the estate value was greater than, less than, or about equal to each breakpoint. If the process reaches completion, the result is a *complete bracket*. If at any point in the procedure the respondent refuses to answer or does not know the value of the estate in relation to a particular breakpoint, the procedure ends, resulting in an *incomplete bracket*. If the upper bound on the estate cannot be established or is reported to be greater than the maximum breakpoint ($2 million), we refer to this case as having an *open top bracket*. In our sample, 305 individuals (16.72% of the sample) have some bound information. *No bracket information* refers to cases where neither an upper nor lower bracket was obtained, which applies to 235 individuals (7.78% of the sample). Finally, *don’t know ownership* means the proxy was not sure whether the decedent left a bequest. Fortunately this applies to only 16 individuals (.53% of the sample). Taken together, approximately 25% of our sample has incomplete estate value data.

C.2 Main imputation procedure

The main imputation sequence has three main steps. It closely follows the procedure used by the RAND Corporation to impute missing income and wealth data in the HRS (Hurd et al., 2016). We first impute estate ownership for those for whom this information is missing. We then impute complete brackets for those with missing or incomplete bracket information. Finally, we impute continuous dollar amounts.

In each step of the imputation, we use the same set of covariates. These include the inverse hyperbolic sine of net worth; age at death and age squared; indicators for whether the respondent was female, non-white, covered by Medicaid, owned a home, intended to leave a bequest greater than \$10,000 or \$100,000, and for different levels of educational attainment; plus indicators for each interview wave. Data on wealth and bequest intentions are taken from the most recent non-missing core data. Home ownership is from the preloaded information for the exit interview. Medicaid coverage is from the exit interview, if available, or the most recent non-missing core data.

To impute estate ownership, we begin by estimating a logit model in which the dependent variable is equal to 1 if the decedent left a bequest and 0 otherwise. We estimate our model of ownership over all decedents for whom this information was non-missing, including those with missing estate values and bracket information. We then predict the probability of ownership for those with missing values, take a random draw from a uniform [0,1] distribution, and impute ownership (non-ownership) if the draw is less than or equal to (greater than) the predicted probability of ownership. The estimates for the logit model appear in column (1) of Table OA1.

In order to impute complete brackets for those with missing or incomplete bracket information, we estimate an ordered logit model. The data for the model include all individuals with reported complete brackets as well as individuals with estate values reported as dollar amounts, which we bin into the HRS (mutually exclusive and exhaustive) estate value brackets. The estimates for the ordered logit model appear in column (2) of Table OA1. From the estimates, we obtain predicted probabilities of appearing in each bracketed interval. Taking a random draw x from a uniform [0,1] distribution, we assign bracket j if $\sum_{i<j} p_i < x \leq \sum_{i\leq j} p_i$, where p_i is the estimated probability of appearing in bracket i, ordered from lowest to highest. For individuals with incomplete bracket information, we adjust the fitted probabilities to be consistent with the available information.

The final step of the main imputation procedure is a nearest neighbor matching assignment of continuous estate values. The data for this step include all individuals who left bequests and whose proxies reported non-missing dollar amounts. The procedure differs depending on whether the observation to be imputed is in the highest bracket (values greater than \$2 million) or not. For those not in the highest bracket, we first obtain fitted values from a regression of the inverse hyperbolic sine of the estate value on the covariates listed above. The estimates from the regression appear in column (3) of Table OA1. Second, we locate the nearest neighbor, which is the decedent within the same bracket with a non-missing estate value whose fitted value is closest to the fitted value of the recipient. Finally, we assign the nearest neighbor's estate value to the recipient. Ties are broken at random. For individuals in the highest bracket, we use a pure hot-deck procedure, randomly assigning a nearest neighbor without covariates. Since we ultimately drop all decedents in this highest category for most of our analyses, this choice is immaterial.

C.3 Adding home values to estates

Apart from the main routine described above, our estate value imputation procedure involves one additional step. After supplying information on the estate value, the proxy respondent is asked whether the supplied value (or brackets) include the value of the primary residence. This question is only asked if the preloaded information indicated that the decedent previously owned a home. We have identified several cases (39 in our final sample of single decedents) in which, although the proxy did not include the value of the home in the estate, the home had been inherited or given away before death and was not previously reported as an inter-vivos transfer. In such instances, we believe the home value *should* have been included in the estate.

To correct for these omissions, we took the value of the primary residence from the most recent non-missing core interview data and added it to the estate value. (Although data on home values are recorded in the exit interview, the core interview housing value data have been more carefully vetted by RAND.) For individuals with continuously reported estate values, we added home values *before* the main imputation procedure. For other individuals, we added home values *after* the procedure. Doing otherwise (e.g., adding the home value to the endpoints of a bracket) would have required that we modify our imputation procedure.[53] Given that relatively few observations were affected, we did not see much value in deviating from RAND's well-established procedure.

C.4 Sensitivity of the imputation routine

Following extensive experimentation with our imputation routine, we have found that the final distribution of estates values is not sensitive to any of the specifics of the procedure. The distribution of estate values depends little on the particular covariates included in the imputation procedure, and in fact, implementing the procedure without covariates yields a very similar distribution. Furthermore, we obtain a similar distribution regardless of whether or not we add home values in cases where proxy respondents did not include these values in the reported estate value.

[53]The reason is that our complete bracket categories are mutually exclusive. If the categories overlapped, we could not longer model the probability of appearing in each bracket using an ordered logit model.

D The Pareto tail of the estate distribution

The right tail of the distribution of wealth in the United States is generally thought to be distributed according to a Pareto (power-law) distribution. A key feature of the Pareto distribution is that, depending on the fatness of the upper tail, some or even all of the moments of the distribution may not exist. Indeed, some estimates suggest that this is the case for the distribution of wealth in the U.S. For instance, estimates from Klass et al. (2006) imply that the mean and all higher moments of the distribution of wealth in the U.S. are infinite. In this section, we examine whether the same applies to the upper tail of the distribution of estate values.

Results Visually, a Pareto tail manifests itself as a linear relationship between the natural log of a variable and the natural log of its anti- (or complementary) CDF. We present this evidence in Panel (a) of Figure OA1. The navy circles are the log of the empirical anti-CDF of estate values plotted against log estate value. For this figure, we use data on all non-missing estate values for our sample of single decedents who left bequests in the 2004-2012 exit interviews prior to our imputation of missing values. The linear pattern is clearly evident in the right tail of the distribution. Imposed on top of the navy circles, the dashed red line depicts the tail of a Pareto distribution that we fit to the data. Typically, a power law only applies above some threshold value of the variable in question. The threshold is captured by the dashed cyan line in the figure.

Following the procedure outlined in Clauset et al. (2009), which we describe just below, we estimate the threshold and the shape parameter, α, of the Pareto distribution. Our estimates indicate that the distribution of estate values follows a power law for estates above approximately \$450,000. We find that the shape parameter α of the Pareto distribution is 2.45. This value implies that the mean of the distribution exists, but the variance and all higher moments do not.

Power-law distribution estimation The density of the Pareto distribution is given by:

$$\text{Prob}\,(X = x) = \frac{\alpha}{x_{min}} \left(\frac{x}{x_{min}}\right)^{-\alpha}$$

where x_{min} is the threshold above which the power law applies and α is the shape parameter of the distribution. Per this parameterization, the m^{th} moment exists only if $m < \alpha - 1$. All moments with $m \geq \alpha - 1$ diverge. For example, when $\alpha < 2$, the mean and all higher-order moments are infinite. When $2 < \alpha < 3$, the mean exists, but higher order moments diverge. The anti- (or complementary) CDF given by:

$$\text{Prob}\,(X \geq x) \;\; = \;\; \int_{x}^{\infty} p\,(X)\,\mathrm{d}X = \left(\frac{x}{x_{min}}\right)^{-\alpha+1}$$

Taking logs reveals the linear relationship we see in Figure OA1 between the log anti-CDF and the log of the data:

$$\log\left(\text{Prob}\left(X \geq x\right)\right) = \left(-\alpha + 1\right)\log\left(x\right) - \left(-\alpha + 1\right)\log\left(x_{min}\right)$$

We follow the approach in Clauset et al. (2009) to estimate the threshold and shape parameter of the Pareto (power-law) distribution. Given a value for x_{min}, we can estimate α by maximum likelihood. The ML estimator has the following analytical solution:

$$\hat{\alpha} = 1 + \left[\frac{1}{N}\sum_{i}\log\left(\frac{x}{x_{min}}\right)\right]^{-1}$$

with standard error:

$$\frac{\hat{\alpha} - 1}{\sqrt{N}}$$

We choose x_{min} to minimize the Kolmogorov-Smirnov distance D between the empirical CDF of the estate distribution and our estimated Pareto distribution:

$$D = \max_{x \geq x_{min}} |S(x) - P(x)|$$

where $S(x)$ is the empirical CDF and $P(x)$ is a Pareto CDF with α equal to the ML estimator. Panel (b) of Figure OA1 shows how D varies with x_{min}. Panel (c) illustrates how the estimate of α is dependent on the choice of x_{min}. In both panels, the dashed cyan line indicates the location of our estimate $\widehat{x_{min}}$.

E Computational appendix

We will discuss here the solution method concerning model ingredients that are novel. We refer the reader to Barczyk & Kredler (2014*a*), Barczyk & Kredler (2018) and their appendices for elements that are already present in past papers. The online appendix to Barczyk & Kredler (2014*a*) contains a description of the Markov-chain approximation methods and how to use the Kolmogorov Forward Equation to forward-iterate distributions.

E.1 Transfers within the state space

As shown above, the gift-giving decision within the state-space is of bang-bang type. To make this operational in our code, we have to tackle two issues. First, we impose bounds on the transfer flows (since we cannot deal with infinite flows or lump-sum transfers). Second, there is a discontinuity in transfer flows when the term $\mu^p = V^p_{a^k} - V^p_{a^p}$ switches signs; we smooth this discontinuity in our computations, which helps with stability of the algorithm. We do so in the same fashion for exchange-motivated transfers Q once μ^p or μ^k become positive, since these transfers have the flavor of gifts then (both agents agree that the maximal transfer possible should flow in this situation).

Bounds on transfers. To make transfer flows bounded, we assume that transfers cannot exceed a multiple of the recipient's income flow. Specifically, we impose the following lower and upper bounds on the net transfer flows (from parent to child):

$$\bar{Q}_l(z) = -\bar{q}y^p_{net}(z), \qquad \bar{Q}_u(z) = \bar{q}y^k_{net}(z), \tag{38}$$

where $\bar{q} > 0$ is a tuning parameter of the algorithm and where $y^k_{net}(z)$ is the kid's net income (after taxes) in state z. As for the parent's net income, we include housing services, i.e. we let $y^p_{net}(z) = income + (r + \delta_h)h^p$, where $income$ is social-security income plus asset income, ra^p net of taxes.

Transfer motives. We now show how we deal with the discontinuity of gifts when the "diagonal derivative" $\mu^p = V^p_{a^k} - V^p_{a^p}$ switches sign. The idea is to let gifts continuously increase to the upper bound once μ^p becomes positive. A problem that we encounter here is that the magnitude of the diagonal derivative depends on the agent's wealth: The marginal value of a dollar decreases when the agent becomes richer. To address this issue, we first construct a measure of the willingness to give that is independent of agents' wealth. To construct this measure (the *transfer motive*), we ask the following question: At which rate τ^i would a transfer have to be taxed (or subsidized) so that player i would be exactly indifferent between giving and not giving a marginal dollar to the other player? Specifically, player i's *transfer motive* τ^i in state z is defined implicitly from the equation

$$V^i_{a^{-i}}(z)[1 - \tau^i(z)] = V^i_{a^i}(z),$$

where $-i$ indexes the other player. From this, we can back out the transfer motive in state z as

$$\tau^i(z) = 1 - \frac{V^i_{a^i}(z)}{V^i_{a^{-i}}(z)}. \tag{39}$$

Smoothing transfer policies. To make transfers continuous in the transfer motive, we apply a continuous function $\phi(\cdot)$ to the transfer motive that quickly increases from 0 to 1 once the transfer motive becomes positive. In practice, we choose the following piecewise-linear function $\phi : [0, \infty) \to [0, 1]$:

$$\phi(\tau) = \min\left\{\frac{\tau}{\bar{\tau}}, 1\right\}, \tag{40}$$

where $\bar{\tau} > 0$ is a parameter. The function prescribes that once τ is above $\bar{\tau}$, we set gifts to upper bound. On the range $\tau \in [0, \bar{\tau}]$, we let gifts linearly increase from 0 to the upper bound.

Algorithm. We set gifts by the following algorithm in our computations for each z in the state space:

1. If $\tau_p(z) \leq 0$ and $\tau_k(z) \leq 0$ (players want to hold on to their wealth), set $g^p(z) = g^k(z) = 0$ for gift-giving decisions and set the bounds for transfers in the bargaining stage to $[\bar{Q}_l(z), \bar{Q}_u(z)]$.
2. Otherwise (at least one of the players wants to move wealth), define a "net transfer motive" $\tau(z) \equiv \tau^p(z) - \tau^k(z)$ and distinguish the following two cases:[54]
   (a) $\tau(z) \geq 0$: Set $g^p(z) = \phi(\tau(z))\bar{Q}_u(z)$ and $g^k(z) = 0$ when calculating gifts under an outside option. Set the candidate transfer under to $Q^*(z) = \phi(\tau(z))\bar{Q}_u(z)$ when trying to find a bargaining solution for an inside option.
   (b) $\tau(z) < 0$: Set $g^p(z) = 0$ and $g^k(z) = -\phi(-\tau(z))\bar{Q}_l(z)$ when calculating gifts under an outside option. Set the candidate transfer under to $Q^*(z) = -\phi(-\tau(z))\bar{Q}_l(z)$ when trying to find a bargaining solution for an inside option.

Choice of tuning parameters. In practice, we set the tuning parameters for the algorithm to $\bar{q} = 2$ and $\bar{\tau} = 0.05$. This means that (i) players can receive maximally twice their income flow as a gift and (ii) this maximum is attained once the net transfer motive τ reaches 0.05.

E.2 Other computational issues

Grid size. Due to the large dimensionality of the state space, we have to strike a balance between how fine we can choose the grid in the different dimensions. We choose a grid size of $N_a = 31$ for the two asset grids with an upper bound of $\bar{a} = 1,500$, leading to a mesh size of $\Delta a = 50$ (here, 1 unit corresponds to 1,000$ in 2010). Our choice for $\bar{a}$ is large enough to ensure that agents always dissave when at this bound, thus the drift points inward, which is important for stability of the algorithm.. For the two productivity grids, we choose grid size $N_\epsilon = 3$. The grid is given by the vector $[-1.25; 0; 1.25]\sigma_w$, where $\sigma_w = .75605$ is the standard deviation of the residual of a Mincer regression for log wages (see calibration). For housing, the grid size is $N_h = 5$. There is one renting state and we let the four house sizes be the vector $[1; 2; 4; 8] \times \Delta a$. We set the time

[54]Note here that this distinction also takes care of situations in which *both* players want to give gifts, and it does so in a fashion that preserves continuity of gifts in the transfer motives. These counter-intuitive situations occur in our computations at the outer margins of the state space (when players are very asset-rich), where extrapolation together with changes in the discrete decisions can create turbulence in the value functions. It turns out that this algorithm deals successfully turbulences in these regions (which are visited only by a tiny fraction of agents in equilibrium).

increment in the algorithm to $\Delta t = 1/38 = 0.026$ years. With this choice, the probabilities in the Markov-chain approximation method stay safely on the positive side: The probability of staying at the same grid point is 0.47 at its lowest. This leads to a time grid of $N_j = 30 \times 38 = 1,140$ points. In total, we thus have a grid with $2 \times N_a^2 \times N_\epsilon^2 \times N_h \times N_j \simeq 100,000,000$ grid points (the multiplication by 2 is due to distinction between the healthy and disabled states). There is also a smaller grid with $N_a \times N_h \times N_j \simeq 100,000$ grid points on which we track children with dead parents.

Updating. The calculation of the model is feasible due to the continuous-time assumption. Continuous time has two key advantages. First, it allows us to derive tight characterizations of equilibrium policies in all stages of the game; these characterizations give us closed-form solutions for policies in the vast majority of cases and thus keep computational cost at a minimum. The second advantage is that when taking the time horizon to zero, interactions between shocks in different dimensions become second-order and can be neglected. In practice, this means that in our Markov-chain approximation it is sufficient to create a Markov chain on the discrete grid that changes in only one dimension at each Δt. When updating value functions at t, the expectation of the value at $t + \Delta t$ takes the form of a sum over a small number of grid points ($\simeq 13$). This linear mapping can be represented by a highly sparse matrix H. This matrix H is a sum of Kronecker products that collects the transition probabilities in the different dimensions. We exploit the tensor structure of the Kronecker-matrix multiplications in the updating step to speed up the computation; the idea of the algorithm is to see value function vectors as a multi-dimensional array and to apply simple linear maps separately for each dimension whenever this is possible. We have made the code available on the Matlab File Exchange under the name "Fast Kronecker matrix multiplication".[55] We use the same routine when mapping forward the distribution over time and when calculating certain statistics on lifetime outcomes (e.g. the probabilities of ever ending up in NH or MA, expected bequests).

Smoothing. We found that solving the model was more challenging than in our previous work (by Barczyk & Kredler). The reason for this is the introduction of a permanent discrete choice: that of selling the house. What allowed us to make progress was to smooth value functions using various approaches. First, and most importantly, we give agents the opportunity to bargain on the house-selling decision; this prevents discontinuities in the kid's value function when the parent abruptly changes the selling decision. Also, in order to prevent false selling decisions due to computational imprecisions, we set the bargaining weight of the strong party to 0.99 (instead of 1) inside the state space. We smooth out the bang-bang transfer decision as described in the previous

[55] See `https://es.mathworks.com/matlabcentral/fileexchange`

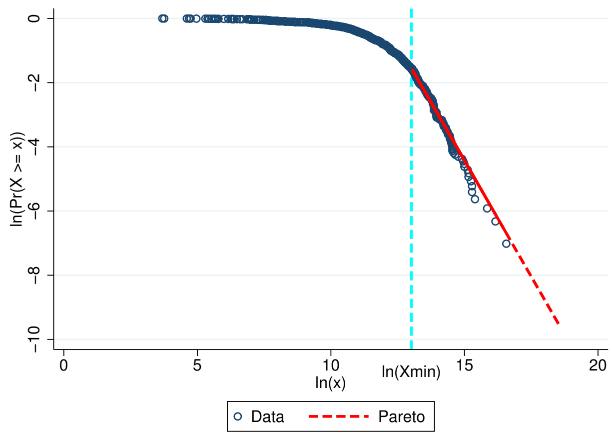
section, Appendix E.1. We also smooth the Medicaid decision by introducing an i.i.d. preference shock to the utility of the Medicaid consumption floor, convexifying the MA uptake probability between the discrete values 0 and 1. Finally, we set the Brownian noise in the laws of motion for a^p and a^k to a rather high value: $\sigma_a = 0.05$.

Extrapolation. At the upper bound of the grids for a^p and a^k, we have to make choices for how to proceed with extrapolation. There are still random movements due to shocks to assets that can make assets increase at this upper bound, though. We reflect back such paths at the boundary, which we found to be more stable than extrapolating value functions. When agents sell large houses, however, they can jump farther out of the state space. To calculate the values under selling, we extrapolate value functions along rays in the $a^k - a^p$-plane under the assumption that consumption functions are linear in (a^k, a^p), while fixing the other states.

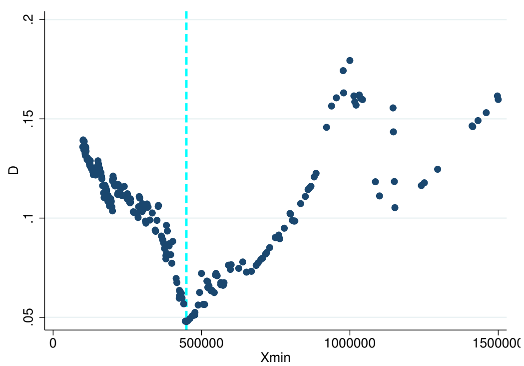
E.3 Measuring the timing of transfers

Artificial panel. We draw an artificial panel with 50,000 model families that we follow from parent age 65 until the parents death. In line with the HRS practice, we "interview" families in intervals of two years (i.e. at age 67.0, 69.0 etc.) and again at their death. Stock variables (financial wealth, housing wealth) are measured at the time of the interview. Flow variables (consumption, inter-vivos transfers, time in different forms of care) are integrated from the last interview until the current interview.

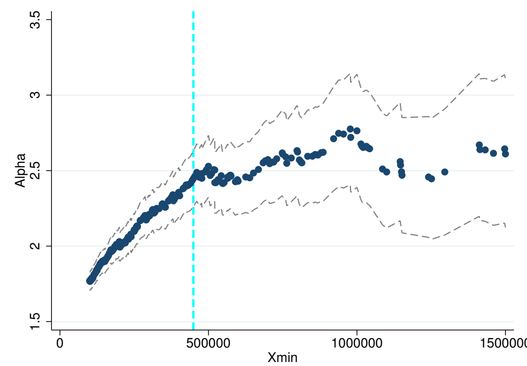
Figure OA1: The Pareto tail of the estate value distribution



(a) Pareto tail



(b) Kolmogorov-Smirnov distance



(c) ML estimates for $\widehat{\alpha}$

Note: Panel (a): The navy circles represent data on reported estate values from the 2004-2012 exit interviews for our sample of decedents prior to imputation of missing values. The figure plots the log anti-CDF of the estate values (y-axis) against the log of the estate values (x-axis). The dashed cyan line is the threshold log estate value above which the power law appears to hold, in the sense that the data appear to be distributed according to a Pareto distribution. The dashed red line is the log anti-CDF of a Pareto distribution with $\alpha = 2.446384344956527$ and $x_{min} = 449184.5$. This line has been shifted down to align with the empirical log anti-CDF. Our estimate for α is obtained using the maximum likelihood estimator. Our estimate for x_{min} was computed as the minimizer of the Kolmogorov-Smirnov distance between the empirical and estimated CDFs: $D = \max_{x \geq x_{min}} |S(x) - P(x)|$ where $S(x)$ is the empirical CDF and $P(x)$ is a Pareto CDF with α equal to the ML estimator. Panel (b): This figure plots D against x_{min} for all possible values of x_{min} in our data. The dashed cyan line indicates where the minimum is located. Panel (c): This figure plots the ML estimates for α at each possible value of x_{min}.

Table OA1: Imputation models

	(1) Any Estate	(2) Bracket	(3) ihs(Value)
ihs(Net Worth) (most recent)	0.0839***	0.164***	0.208***
	(0.0102)	(0.0184)	(0.0221)
Female	0.269**	-0.0472	-0.119
	(0.111)	(0.110)	(0.187)
HS Educ or GED	0.233**	0.227*	0.395*
	(0.115)	(0.129)	(0.218)
Some College	0.248*	0.338**	0.549**
	(0.150)	(0.150)	(0.256)
College+	0.626***	0.914***	0.832***
	(0.209)	(0.178)	(0.293)
Age	0.0739	-0.0205	0.218*
	(0.0600)	(0.0734)	(0.128)
Age Squared	-0.000297	0.000324	-0.00113
	(0.000374)	(0.000452)	(0.000784)
Non-white	-0.459***	0.0291	0.239
	(0.116)	(0.157)	(0.267)
Owned Home 0/1 (preload)	0.869***	0.752***	1.163***
	(0.122)	(0.120)	(0.200)
Medicaid Coverage (most recent)	-0.892***	-1.076***	-1.654***
	(0.104)	(0.141)	(0.228)
Intended Bequest 10k+ (most recent)	0.00549***	0.00271*	0.00304
	(0.00142)	(0.00155)	(0.00267)
Intended Bequest 100k+ (most recent)	0.00914***	0.0167***	0.00920***
	(0.00194)	(0.00159)	(0.00254)
N	2922	1402	1127
R^2			0.363
adj. R^2			0.356
pseudo R^2	0.305	0.176	

Note: Standard errors in parentheses. * p<.1, ** p<.05, *** p<.01. *ihs* refers to the inverse hyperbolic sine: $\ln\left(x + \sqrt{1+x^2}\right)$. Net worth and bequest intentions are taken from the most recent available core interview data. Medicaid coverage is taken from the exit interview, if available, or the most recent core data otherwise. Age is age at death. Home ownership is from the preloaded information for the exit interview. Specifications also include a constant (not reported).

Table OA2: Types and frequencies of estate value reports

	N	Percent	Cum. Percent
No asset	1,180	36.57	36.57
Continuous report	1,202	37.25	73.81
Complete brackets, closed	302	9.36	83.17
Complete brackets, top bracket	1	0.03	83.20
Incomplete brackets, closed	46	1.43	84.63
Incomplete brackets, open top	224	6.94	91.57
No bracket information	253	7.84	99.41
Don't know ownership	19	0.59	100.00
N	3227		

Note: Counts and frequencies are for our final sample of single decedents. No asset means the decedent left no bequest. Continuous report refers to cases in which the proxy respondent reported the dollar amount of the estate. Brackets refer to cases in which the dollar amount of the estate could not be ascertained, but upper and/or lower bounds on the value were reported. The procedure used to obtain these bounds involves the interviewer cycling through a sequence of pre-defined "breakpoints" and asking the respondent whether the estate value was greater than, less than, or about equal to each breakpoint. If the process reaches completion, the result is a complete bracket. If at any point in the procedure the respondent refuses to answer or does not know the value of the estate in relation to a particular breakpoint, the procedure ends, resulting in an incomplete bracket. If the upper bound on the estate cannot be established or is reported to be greater than the maximum breakpoint ($2 million), we refer to this case as having an open top bracket. No bracket information refers to cases where neither an upper nor lower bracket was obtained. Finally, don't know ownership means the proxy was not sure whether the decedent left a bequest.