Evaluating Long-Term-Care Policy Options, Taking the Family Seriously☆

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Abstract

We propose a dynamic non-cooperative framework for long-term-care (LTC) decisions of families. We first document the importance of informal caregiving and economic determinants of care arrangements in the US. We then build a heterogeneous-agents model with imperfectly-altruistic overlapping generations to account for the patterns we find. A key innovation is the availability of informal care, which is determined through intra-family bargaining. This has important implications for self-insurance and opens up a new margin in response to policy. The model generates a host of realistic care arrangements. We calibrate the model, and find that the model captures the observed care arrangements well. We ask what the implications of German-style LTC insurance would be for the US. We find that an informal-care subsidy substantially reduces Medicaid reliance; the reduction of tax revenues due to lower labor supply by caregivers is small. Combining a cut to the current Medicaid program with an informal-care subsidy is budget-neutral, and yields welfare gains in both the short and the long run.

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1 Introduction

A 21^{st}-century challenge to governments is to find ways to deal with a growing number of elderly citizens in need of care. In Germany and Japan, for example, governments have already stepped in; both countries have universal long-term-care (LTC) insurance for the elderly.[1] In the US, the Affordable Care Act signed into law in 2010 contained legislation on a market-based LTC policy, which subsequently failed. This led to renewed debates on LTC policy options. In a recent report to congress the bipartisan Commision on Long-Term Care (2013) forcefully defends the importance of family-caregivers and the need to enable the elderly to stay at home, shifting attention away from private LTC insurance.[2] Debates about LTC reform are bound to intensify as the ratio of elderly who require LTC to the working-age population is projected to increase from 6.4% in 2010 to 7.4% in 2020, and to 9.6% in 2030 (Johnson et al., 2007). Medicaid, currently the primary government insurance mechanism for LTC, is means-tested and leaves LTC risks largely uninsured. As a result, LTC poses one of the major financial risks for elderly Americans (Brown & Finkelstein, 2007). Simultaneously, private LTC insurance is unpopular. Only 14% of the elderly have a private policy (Brown & Finkelstein, 2011), and only 4% of all LTC expenditures are paid for by private insurance (CBO, 2004).[3] Finally, nursing-home prices have been rising quickly, a trend likely to continue due to the aging of the population, which will put further pressure on private and public finances.[4]

We argue that the evaluation of LTC policy options has to take seriously the response of the family. After all, in the US and elsewhere, the family constitutes a very important source of care. For example, subsidies for nursing-home care may merely crowd out informal care, thus

[1]The gerontological literature defines the need for LTC as becoming dependent on assistance from another person due to functional limitations, such as having difficulties with activities of daily living (e.g. getting in and out of bed, getting dressed, showering, and eating) or with instrumental activities of daily living (e.g. buying groceries, going to the doctor, and going for a walk).

[2]Also most other countries that have undertaken LTC reforms have shied away from market-based solutions. They have instead opted for universal insurance schemes, as opposed to the means-tested Medicaid program in the US, see Gleckman (2010).

[3]Reasons for the low take-up rates of private LTC insurance mentioned in the literature are market failure because of adverse selection, asymmetric information, and problems in the verification of care needs; see Brown & Finkelstein (2007) and Finkelstein & McGarry (2006). Brown & Finkelstein (2008) find that Medicaid substantially crowds out private LTC insurance. It has also been suggested that individuals shun market insurance because they rely on the family instead; see, for example, Ameriks et al. (2007).

[4]For example, Stewart et al. (2009) document that annual private pay nursing home prices grew by 7.5% annually from $8,645 in 1977 to $60,249 in 2004. Medicaid reimbursement rates grew by 6.7% annually from $9,491 in 1979 to $48,056 in 2004. In 2015, Genworth (2015) reports a median annual cost for a private room in a nursing home to be $91,250 and $80,300 for a semi-private room with a historical five-year annual growth rate of 4%.

providing little additional insurance at a high cost to the government. On the other hand, subsidizing nursing homes may be less costly than its face value since it allows family caregivers to stay in the labor force and pay taxes. An alternative measure, subsidies to informal care, may be expensive if many informal caregivers leave their jobs (e.g. working-age children), or simply ineffective if it goes primarily to infra-marginal caregivers (e.g. retired spouses). On the positive side, encouraging informal care can help to keep Medicaid spending in check.

We see our main contributions as the following. First, we document the importance of family-provided care and study its economic correlates and the compensation of caregivers in the Health and Retirement Study (HRS). Second, we build a fully-dynamic non-cooperative model of two interacting generations. An innovation with respect to the literature is that there are both altruistically-motivated and exchange-motivated transfers in the model. The model gives rise to a wide range of care arrangements and their financing, which we characterize. Third, we calibrate the model, using a quantitatively realistic life cycle, family, and risk structure, and analyze a set of policy reforms. With respect to the macroeconomic old-age-risks literature, our innovation here is that we take into account the family margin when it comes to the response to LTC policies, and that we show that this margin is important quantitatively.

Using the HRS, we find that almost two-thirds of all hours of care are provided informally, particularly by retired spouses and working-age children. The remaining one-third of care hours comes from formal sources, primarily nursing homes (formal home care playing a more minor role).[5] We find that children's opportunity costs in the labor market and parental wealth (typically housing) matter significantly in the determination of care arrangements.[6] We also find that, both within and across families, caregiving children receive higher transfers (especially in the form of co-residence, but also by being signed over home ownership during the parent's lifetime). These facts strongly hint at an intra-family bargaining channel in the care decision.[7]

[5] See also Stoller & Martin (2002); Wolff & Kasper (2006); etc. Another way of gauging the importance of informal care is to impute its economic value. Arno et al. (1999) provide an estimate of the economic value of informal caregiving of $196 billion in 1997; this is equivalent to approximately 18 percent of total national health-care spending ($1,092 billion) in 1997. A more recent estimate by the *Aging in Place* (2011) puts the economic value of informal care at $450 billion. In contrast, national spending on formal health care at home was only $32 billion and $83 billion for care in nursing homes.

[6] Our findings here are in line with the literature. Garber & MaCurdy (1990) show that owning a home decreases the probability of going to a nursing home. Headen (1993) finds that wealth significantly reduces the hazard of nursing-home entry and that nursing home entry is positively related to opportunity costs of informal caregivers in the family. Van Houtven et al. (2013) and Skira (2015) focus on the interactions between labor supply and caregiving decisions. Both papers find that opportunity costs of caregiving are important.

[7] See also, Bernheim et al. (1985), who argues that parents strategically withhold resources to "purchase" attention from their children with a larger bequest. Cox & Rank (1992) find evidence that parents exchange gifts for services from their children. Boersch-Supan et al. (1992) find that those with higher incomes are less likely

To capture these facts, we write down a dynamic heterogeneous-agents model with overlapping generations. We model the provision of informal LTC by intra-family bargaining. In each period, parent and child bargain; if they agree on informal care, a financial transfer may flow in exchange for a time transfer (care). However, households are also altruistic towards each other. They take into account the other's economic situation and preferences in the bargaining process and can make transfers that are purely altruistic in nature (*gifts*). As a result, our setting gives rise to a host of care arrangements, which we characterize. The child may provide informal care (i) in exchange for immediate transfers, (ii) without contemporaneous compensation but in anticipation of a higher bequest, or (iii) out of pure altruism, receiving neither transfers nor a bequest. Formal care may be (i) paid by the parent alone, (ii) subsidized by transfers from the child to varying degrees, or (iii) paid for by Medicaid. When comparing the model-generated care and transfer arrangements with the empirical ones, we find that the model captures the observed care arrangements well, but falls short to account for care which takes place without any measurable economic benefits to caregivers (interpreted as altruistic by our model).

We calibrate our model to the US economy and use it to evaluate several policy options based on Germany's LTC reform for the US. We also study changes to the size of the Medicaid program, which is a hotly-debated topic in the US. We find that a German-style informal-care subsidy is partly self-financing since it decreases reliance on Medicaid. However, subsidizing informal care has the cost that it reduces labor supply of caregivers; but we find that this cost is relatively small as primarily individuals of lower productivity exit the labor force. The subsidy's cost can be reduced substantially if it is only paid out to working-age caregivers. Over the short run, there are sizeable welfare gains, which turn somewhat negative in the long run, due to higher taxes and lower wealth accumulation. A German-style subsidy to private payers of nursing homes is more expensive and less popular; it benefits primarily richer families. Finally, we find that an attractive policy choice is to combine a cut to Medicaid with an informal-care subsidy. This policy is budget-neutral and yields both short- and long-run welfare gains. It strongly increases informal care and reduces Medicaid reliance, especially among poorer families.

Our paper is part of a research agenda that extends heterogeneous-agents models to altruistic agents who lack the ability to commit, see Barczyk and Kredler (2014a,2014b). A key strength of this modeling approach is that *both* the parent and the child generation within a family are

to go to a nursing home, possibly because they use it to make transfer payments to children. Norton & Houtven (2006) and Norton et al. (2013) find evidence for such an exchange specifically for caregiving; Brown (2006) and Groneck (2015) find empirical evidence that caregiving children obtain larger bequests than their non-caregiving siblings. Johnson & Sasso (2006) also find evidence consistent with bargaining.

allowed to save.[8] This feature is crucial for evaluating LTC policy. For the elderly, savings are a key source of insurance. Also, the Medicaid means test explicitly conditions on the *elderly household's* wealth and not on that of the extended family. As for children, they tend to be in their prime saving years when facing the decision if to give care to a frail parent or not. Thus their valuation of financial transfers or bequests will depend strongly on how much they have saved already, which cannot be addressed in a setting that rules out savings.

Methodologically, this is the first paper in which we include a time transfer (informal care) alongside financial transfers. The substantial modeling innovation here is that this transfer is determined by intra-family bargaining. This gives rise to exchange-motivated transfers alongside the altruistically-motivated transfers (gifts) we had considered in our previous work. To the best of our knowledge, we are the first to study a dynamic model that includes both of these commonly-used transfer motives. With respect to Barczyk and Kredler (2014a,2014b), we also add an overlapping-generations structure. Together with the care decision, this gives rise to the possibility that children give care in anticipation of a future bequest (although there is no explicit contract governing this exchange). Finally, in contrast to Barczyk and Kredler (2014a,2014b), we study a concrete policy question in a rich and fully-calibrated environment with a proper life cycle, a realistic household structure, and various sources of idiosyncratic risks.

Our paper aims to combine elements from two literatures to obtain credible recommendations for LTC policy. The first is an applied microeconomic literature, which is explicitly concerned with the trade-offs faced by family caregivers and shows that caregiving reduces labor supply.[9] The second is a macroeconomic literature that studies old-age risks and its aggregate implications, but neglects the family channel. So far, the macroeconomic literature on old-age risks has been concerned with explaining why the elderly do not reduce their wealth as predicted by the standard life-cycle model (the *retirement savings puzzle*). In a nutshell, it finds that uninsured medical-expense risk, especially LTC-expenditure risk, could be important to resolve this puzzle.[10] Introducing the family opens up a new insurance channel which chal-

[8]Usually, this complication is circumvented in the literature because of the technical difficulties it entails; see Barczyk & Kredler (2014*a*) for a literature review. Also, in contrast to the unitary and collective model, the timing of financial transfers and the dynamics of the wealth distribution within the family is determined in our setting.

[9]For example, Johnson & Sasso (2006) find that time help to parents strongly reduces female labor supply at midlife. Van Houtven et al. (2013) find that the provision of informal care has a negative and significant effect on the extensive and intensive margin of female labor-force participation. Skira (2015) finds that current care provided by a daughter also affects future labor-force participation and wages.

[10]Hubbard et al. (1995) study the interaction of means-tested social insurance programs and precautionary savings in the presence of uncertain earnings and out-of-pocket medical expenses. They show that a consumption floor is able to explain low wealth levels for households with low life-time earnings relative to the predictions of the

lenges the solution of the retirement-savings puzzle by high medical expenditures somewhat. In our setting, LTC expenditures are less risky since they are partly discretionary – they can be avoided by home production of care –, whereas they are usually modeled as a spending shock in the previous literature. Thus, the need for self-insurance through savings is reduced.

More recently, the macroeconomic literature has begun to focus on policies relevant for LTC risks, such as Medicaid and Medicare (for example, Attanasio et al., 2011, Braun et al., 2015, and DeNardi et al., 2013). However, our results indicate that these papers miss an important margin by neglecting the family. For example, we find that in the long run a Medicaid expansion drives twice as many people from informal care into Medicaid than from private-payer nursing homes. A model without family only captures the shift of private payers to Medicaid and thus vastly underestimates the cost increases in the Medicaid program. The presence of the family also matters for welfare implications of policies. For example, we find that a cut to Medicaid is partially offset within the family through additional informal care and financial help from children. A model without family leaves individuals with fewer margins of adjustment and thus likely overstates welfare losses. Finally, our model opens up the possibility to evaluate a wider range of policies, such as informal-care subsidies, than is currently feasible.

2 Empirical facts on LTC

We first provide a brief background on the US nursing-home sector. We then document facts about care arrangements, caregivers, determinants of informal care, and transfers that informal caregivers receive. We refer the reader to the Online Appendix for details on our empirical work.

2.1 How does the nursing-home sector work?

Nursing-home residents in the US pay for care mainly out-of-pocket or by qualifying for means-tested Medicaid. Private LTC insurance is limited, paying for about 4% of nursing-home expen-

life-cycle model. DeNardi et al. (2010) show that medical expenditures, particularly nursing-home expenditures, are an important ingredient in solving the retirement savings puzzle and that lowering the government safety net not only influences the poor but also the rich because of the undesirability of the consumption floor. Ameriks et al. (2011) attack the question on why we see a lack of wealth decumulation and little annuitization in retirement head on by asking people. They find that respondents strongly fear the possibility of having to rely on public care (Medicaid) for LTC and are thus reluctant to convert liquid wealth into a fixed income stream. Kopecky & Koreshkova (2014) also study uncertain LTC expenditure and find that after earnings risk, nursing-home risk is the most important determinant of precautionary savings.

ditures (CBO, 2004). Medicaid is the dominant purchaser of nursing-home services, accounting for at least 50% of all revenues of nursing homes (Grabowski et al., 2008). Medicare only covers stays up to 100 days following a hospital stay, and thus accounts for only about 11% of nursing homes' revenues (Norton & Newhouse, 1994).

In principle, any nursing home can admit Medicaid-financed payers, but does not have to. The only constraint is that the facility is certified to accept Medicaid or Medicare residents, with certification being basically universal (Grabowski et al., 2008). Private-paying residents are charged the price set by the nursing home; nursing homes compete freely for these private payers. Individual states set Medicaid per-diem reimbursement rates, which are typically 10 to 30 percent below the private price (Norton, 2000; Stewart et al., 2009). Thus it is perhaps unsurprising that nursing homes preferentially admit private payers (see, for example, Ettner, 1993). In order to qualify for Medicaid, an individual must contribute all assets in excess of $2,000, subject to a homestead exemption, and all monthly income. Medicaid only covers the most basic necessities (room, board, and nursing care), leading to a lower quality of life, and so individuals have been found to be averse of becoming reliant on it (Ameriks et al., 2011). Medicaid is the only safety net available for LTC in the US; there is neither an informal-care subsidy nor a general (non-means-tested) formal-care subsidy, as there are in Germany.

2.2 How frequent are the different LTC arrangements?

We use the Health and Retirement Study (HRS) to document facts about LTC in the US. The HRS is representative of the US population of age 50 and above. It contains specific information about a respondent's functional limitations with regards to activities of daily living (ADLs) and instrumental activities of daily living (IADLs), about the identity of the caregiver(s), and on hours of care each helper provides.[11] We construct a sample (the *care sample*) that includes all individuals who receive help due to functional limitations. We differentiate between an individual's residency: community, i.e. at home, or nursing home (NH); the type of care provision for community residents: informal care (IC), formal home care (FHC), or a mix of IC and FHC; and whether nursing-home residents are private payers (PP) or Medicaid(MA)-supported.

Table 1 shows that the vast majority of respondents in our care sample live in the community. When living in the community, IC is most common. Few individuals rely solely on FHC, while a mix of FHC and IC is somewhat more common. Only 13.2% reside in a nursing home, about

[11] The HRS does not collect hours of care for nursing-home respondents. We assign one dummy-helper to each such individual and impute care hours from a regression of care hours on (I)ADLs, dementia, and other controls for individuals living in the community.

61.3% of such individuals being supported by Medicaid.[12]

Since the care sample contains also relatively young individuals with minor care needs and good opportunities to obtain care from family members, it may overstate the importance of IC. To address this concern, we restrict the care sample further to those born prior to 1924 (*AHEAD singles* sample). About two-thirds of AHEAD singles still live in the community, with IC as the dominant source of care; the importance of FHC increases but is nowhere near that of IC. The importance of NH increases substantially, but stays at around one third of all cases. The MA-recipiency rate among these nursing-home residents is 51.4%.

Table 1: Care arrangements

Case counts							
	community				*nursing home*		
Sample	IC	FHC	IC+FHC	Total	MA	PP	Total
Care sample	72.0%	4.4%	10.4%	86.7%	8.2%	5.1%	13.3%
AHEAD singles	45.3%	7.5%	16.2%	69.0%	15.9%	15.1%	31.0%

Data source: HRS waves 2000-2010. *Care sample* includes individuals who receive help due to functional limitations. *AHEAD singles* are those in the care sample born prior to 1924 (HRS's AHEAD cohort). Table shows: fractions of individuals living in community, who receive exclusively informal care (IC), formal home care (FHC), or a mix of IC and FHC; and fractions of nursing home (NH) residents, who are Medicaid (MA) supported and private payers (PP). Fractions of NH coverage, i.e. MA or PP, based on individuals with nursing-home stay of at least 100 days to exclude Medicare cases. Respondent-level weights are used.

Hours (out of all hours)			
Sample	IC	FHC	NH
Care sample	63.5%	9.8%	26.7%
AHEAD singles	42.8%	13.3%	43.9%

Data source: HRS waves 2000-2010. Fractions contributed by IC, FHC and NH to all hours of care. Respondent-level weights are used. 32.1mil annual total hours (unweighted) in care sample. 11.3mil annual total hours in AHEAD singles sample.

However, even among the oldest individuals there is still large variation in the severity of care needs, and it is to be expected that the most severe cases end up in nursing homes, whereas less severe cases are being taken care of informally. In order to account for the intensity of care, the second part of Table 1 shows the percentage of total hours of care made up by different forms of care. Indeed, formal care increases in significance, but IC still keeps its dominant role. Almost two-thirds of all hours of care are provided informally in the care sample. Within formal care, nursing homes provide about three times as many hours as FHC. Among the oldest-old

[12] We categorize individuals who are partially covered by Medicaid as Medicaid-supported if annual nursing-home expenditures are below $10,000; Medicare individuals are excluded; Table 9 in the Online Appendix provides an overview of Medicaid coverage and out-of-pocket expenditures. The Medicaid numbers are similar to those reported by Grabowski et al. (2008). They use data of all nursing home residents from 7 states obtained from the Minimum Data Set for nursing homes and find that the Medicaid recipiency rate is 64%, private payers make up 32%, and other type of payers account for 4%.

widow(ers)/singles, IC hours continue to be substantial and are in the ballpark of care provided in nursing homes.

2.3 Who provides care, and how much?

We now ask who the informal caregivers are. We split informal helpers into two groups depending on whether they face opportunity costs in the labor market or not. Helpers of retirement-age are defined as *old* (these are most often spouses), and those of working-age are defined as *young* (these are typically children of the disabled). We also create a residual informal-caregiver category *other* for helpers who are relatives or friends, but for whom we do not know the age. We define three care-intensity categories: weekly hours of care of <7.5 is *light*, 7.5-19 weekly hours is *medium*, and *heavy* stands for at least 20 weekly hours (equivalent to a part-time job or more). We classify care hours that FHC and NH helpers provide into the same intensity categories. We define a respondent as *disabled* when (s)he receives 90 or more monthly hours of care.[13]

Table 2: Who provides care, and how much?

	# Cases (out of all helpers)			Hours (out of all hours)		
Helper type	light	medium	heavy	light	medium	heavy
young	28.6%	5.7%	**9.1**%	3.3%	3.3%	**23.1**%
old	13.8%	3.1%	**9.4**%	1.9%	1.9%	**25.3**%
other	8.0%	1.1%	1.4%	0.7%	0.6%	3.3%
FHC	4.6%	1.9%	3.7%	0.7%	1.1%	8.0%
NH	0.6%	0.6%	**8.5**%	0.0%	0.4%	**26.3**%
total	55.6%	12.4%	**32.1**%	6.6%	7.3%	**86.0**%

Data source: HRS waves 2000-2010. Joint distribution of care intensity and caregiver type. Helper-intensity categories *light*, *medium*, and *heavy*, correspond to < 7.5, $7.5 - 19$, and > 19 weekly care hours, respectively.

Hours (out of all hours) among disabled

Partner status	old	young	other	FHC	NH
any	**28.4**%	**29.5**%	4.3%	9.7%	**28.1**%
married/coupled	**64.7**%	14.6%	1.3%	5.9%	13.5%
widow(er)/single	1.9%	**40.4**%	6.5%	12.4%	**38.8**%

Data source: HRS waves 2000-2010. Restricted to individuals receiving monthly hours of care of at least 90 hours (*disabled* individuals). Partner status is of respondent. Shows fractions of hours disabled respondent receives from helper types conditional on partnership status.

Table 2 shows the joint distribution of care intensity and helper type, both for helper counts and for hours. The majority of all helpers provide care of light intensity, most of them be-

[13]This is in line with the classification based on the German LTC insurance system.

ing young. Among heavy helpers, young, old, and nursing-home helpers are about equally common. Heavy helpers make up about one-third of all helpers, but provide the lion's share of all hours of care. This indicates that caregiving is heavily concentrated on some helpers. Consistent with this notion, we find that disabled elderly living in the community receive care most commonly from one heavy helper.[14] The lower part of Table 2 is restricted to *disabled* individuals – they obtain the lion's share of all hours of care – and shows the fractions of care hours provided by the helper types depending on the respondent's partnership status. We see that old IC helpers are critical when the respondent is married/coupled. For widow(ers)/singles the young and nursing home play a central role and are of similar importance.[15]

From the perspective of children, we find that care is usually concentrated on one child. In families with multiple children and at least one heavy-helper child, it is most often exactly one child who takes on this role (86.2%). When considering characteristics of kid heavy-helpers we find that they are middle-aged (average age is 48); predominantly female (74%); are less often full-time employed (38.4%, versus 64.7% among all *young* in our sample); and less educated (17.9% have a college degree, versus 24.1% among all *young*). Additional characteristics of heavy-helper children in comparison to other children are shown in Table 4 of the Online Appendix.

2.4 Which families opt for informal care?

We have seen that IC is predominant among disabled individuals who are married. It is reasonable to expect that this arrangement is not very responsive to policy changes as care among spouses usually takes place automatically. However, for disabled widow(ers)/singles, children and nursing homes are the main sources of care, and we would expect care arrangements to be more responsive to policies among this group. But, what explains that in some families IC takes place while not in others?

In order to gain an understanding we estimate a linear probability model for the IC choice depending on covariates drawn from both the parent and child households. The results are shown in Table 3 (for children, a characteristic is that of the average across all children of the

[14]To be precise, among disabled married/coupled individuals, 3.7% have no heavy helper, 83.7% have exactly one heavy helper, 10.3% have two, and 2.3% have three or more. Among disabled widow(ers)/singles living at home, 10.5% have no heavy-helper, 69.2% have exactly one heavy helper, 16.0% have two, and 4.3% have three or more heavy helpers.

[15]Table 3 in the Online Appendix shows widow(er)/singles' characteristics depending on who their main caregiver is.

Table 3: Linear probability model for informal care

	Care sample		Single sample		Disabled single sample	
	all	disabled	all	disabled	MA eligible	MA ineligible
Covariate	(N=11,501)	(N=5,197)	(N=5,756)	(N=2,818)	(N=1,566)	(N=1,252)
married/partnered	0.165***	0.229***				
	(0.00949)	(0.0160)				
siblings	0.00215	0.000539	0.00481	0.000869	0.00270	-0.00287
	(0.00160)	(0.00285)	(0.00304)	(0.00478)	(0.00593)	(0.00822)
# kids	0.00675***	0.0114***	0.0100***	0.0137***	0.0115*	0.0190*
	(0.00163)	(0.00276)	(0.00278)	(0.00411)	(0.00492)	(0.00746)
grandkids	-0.000244	-0.00596	-0.00308	-0.0116	-0.00860	-0.0121
	(0.00366)	(0.00548)	(0.00535)	(0.00704)	(0.00813)	(0.0134)
# (I)ADLs	-0.0412***	-0.0414***	-0.0465***	-0.0414***	-0.0441***	-0.0383***
	(0.00164)	(0.00241)	(0.00250)	(0.00362)	(0.00485)	(0.00557)
dementia	-0.104***	-0.125***	-0.123***	-0.126***	-0.120***	-0.134***
	(0.0103)	(0.0143)	(0.0161)	(0.0202)	(0.0277)	(0.0301)
low wealth	0.0898***	0.102***	0.112***	0.103***	0.0962**	0.0665
	(0.0102)	(0.0159)	(0.0152)	(0.0229)	(0.0323)	(0.0439)
medium wealth	0.110***	0.145***	0.130***	0.129***	0.193***	0.0802
	(0.0118)	(0.0192)	(0.0189)	(0.0274)	(0.0485)	(0.0451)
high wealth	0.0972***	0.0897***	0.122***	0.146***	0.172	0.117*
	(0.0149)	(0.0242)	(0.0242)	(0.0332)	(0.106)	(0.0458)
log income	0.0275	0.0569	0.105*	0.247***	0.136	0.293**
	(0.0269)	(0.0563)	(0.0435)	(0.0533)	(0.0743)	(0.0989)
(log income)^2	-0.00191	-0.00280	-0.00677**	-0.0146***	-0.00678	-0.0179***
	(0.00140)	(0.00294)	(0.00249)	(0.00311)	(0.00523)	(0.00514)
some college (kid)	-0.0145	-0.0283*	-0.0350*	-0.0565**	-0.0387	-0.0774*
	(0.00829)	(0.0140)	(0.0147)	(0.0217)	(0.0284)	(0.0333)
college (kid)	-0.0818***	-0.110***	-0.142***	-0.184***	-0.165***	-0.200***
	(0.0129)	(0.0199)	(0.0209)	(0.0273)	(0.0406)	(0.0386)

Linear probability model with dependent variable IC. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Three samples: (1) the care sample (see text), (2) widower/singles from the care sample, and (3) disabled widower/singles from the care sample. *All*: regression uses all individuals in sample. *Disabled*: restricted to individuals receiving at least 90 hours of monthly care. *Medicaid (MA) eligible*: non-housing wealth < $2,000 and income < $20,500. For care sample, which includes couples and singles, low wealth is $7.5k-$135k, medium wealth is $135k-$405k, and high wealth is >$405k; the omitted category is wealth below $7.5k. For regression using singles we lower the wealth thresholds: low wealth is $5k-$90k, medium wealth is $90k-$270k, and high wealth is >$270k; the omitted category is wealth below $5k. Income includes social security, and all other sources of income. Some college (kid): average years of children's education is between 13-16 years. College (kid): 16 years and more; the omitted category is that average schooling is below 13 years. Not all covariates are shown here; see Online Appendix Table 5 for full regression.

care recipient).[16] The first column shows that the presence of a spouse/partner is a key predictor of IC, even after controlling for a variety of other characteristics. For all other covariates, their coefficients are quite robust across all specifications (we restrict the sample to singles in the second column and further to disabled singles in the third column). The number of children has a significant positive impact on the likelihood of IC. But the effect is small compared to the large negative effect that children's education has, indicating that children's opportunity costs in the labor market are the key for the IC decision. Household wealth makes IC more likely when moving from no wealth (the omitted category) to low wealth. Differences in the likelihood when moving to higher wealth categories are small and statistically not significant. The effect of elderly's income is not robust across specifications. In our preferred specification, the disabled single sample, the effect is negative on the relevant income range, but the effect is very weak.[17]

Under the US system, incentives for entering a nursing home are different for the poor (who are MA eligible) and the rich. The final column splits disabled singles into MA-eligibility groups as a robustness check. We see that even though a disabled individual is MA eligible, wealth increases the likelihood of IC (recall that MA-eligible can own housing wealth due to the homestead exemption). The coefficients on most variables are similar to the other specifications, but the estimates are less precise due to smaller sample size.

Finally, in all specifications we see that an individual's frailty (the number of (I)ADLs and dementia – whether a doctor has ever diagnosed a memory-related disease) have a large negative impact on IC. In view of this result, one may wonder in how far IC really is a feasible choice for the severely disabled, and if no,for how many elderly a nursing home is the inevitable outcome. We turn to this question now.

2.5 Is IC really a choice for all elderly?

Despite the negative association of disability measures with IC found above, our data suggests that IC indeed *is* a choice even for the most severely disabled.[18] We find that 64% of respon-

[16]The dependent variable is whether or not IC takes place. An individual who receives a mix of FHC and IC is counted as a formal care recipient if the majority of hours of care is due to FHC; vice versa, if the majority of hours stem from IC we count the individual as an IC recipient. We also considered other specifications than that shown in the table, such as logits and models with interaction terms. Our results were robust across specifications.

[17]When comparing an individual at the 10th percentile of the income distribution with one at the 90th percentile, all other things equal, the decrease in the probability of IC is 4%.

[18]This is in line with Charles & Sevak (2005), who find that informal home care substantially reduces the probability of long-term nursing home use, that is, informal care and nursing home care are substitutes.

dents who currently have a memory-related disease still reside at home. Even among the most frail (10 out of 10 possible (I)ADL conditions plus memory-related disease), about 30% of respondents are at home. These numbers are not that surprising if we think about the nature of the (I)ADL limitations; they do not require sophisticated technology but rather large amounts of low-skilled labor to be taken care of.[19] Consistent with this, we find that many care recipients living in the community indeed report that they receive high amounts of care. Among community residents with 6 or more (I)ADL issues, 50% receive more than 192 care hours per month (or more than 6 hours per day), 25% receive more than 480 monthly hours (16 daily hours), and 10% of them even report monthly hours of 621 or more (20.7 per day). When the elderly is additionally afflicted by a memory-related disease these numbers become substantially higher especially at the median. In summary, our data is thus in line with the notion that there is always a choice between staying in the community and going to a nursing home.

Relatedly, one may wonder for how many elderly formal care is the only option, simply because they lack a social network. In our sample, however, such cases are rare. For example, among singles with heavy care needs, only 13% are childless. Even among these childless disabled singles, 71% report at least one informal caregiver, suggesting that they have relatives or friends they are in close contact with. A full 26% of childless disabled singles receives the majority of their care from (an) informal caregiver(s). This suggests that even among childless singles, informal care is an option for most people.

2.6 How are informal caregivers compensated?

We now present evidence that child caregivers receive substantial economic compensation. We define a *child-caregiver family* as a disabled widow(er)/single parent with at least one heavy-helper child who receives the majority of care hours informally (recall that in these cases there is typically one heavy-helper kid). We refer to transfers that occur in the same time period as care is reported as *contemporaneous exchange*. We first present evidence *across families*, that is, we measure transfers from the parent generation to the child generation in child-caregiver families and compare them to *formal-caregiver families*, i.e. disabled widow(er)/single parents that receive the majority of care formally. In child-caregiver families for which there are no

[19] Note that being frail is not the same as requiring hospitalization because a respondent will be in such bad health that she *has* to be in an institution. A nursing facility is also not designed to handle severe medical conditions. If individuals are in need of medical care, the HRS categorizes these cases as hospital stays. In our model, these stays (which are typically of much shorter duration than nursing-home stays) will be included into the medical-cost shock process.

such transfers, we study how much wealth the parent holds, and refer to it as *potential bequest*, a mechanism which previous literature has found to be important.

Contemporaneous exchange: 62.3%. The most common form of compensation we find is co-residence.[20] In 47.3% of all child-caregiver families, children live rent-free in the parent's home (in the vast majority it is only the heavy-helper child), whereas this is the case in only 3.9% of formal-caregiver families. Considering that median gross rents in the US in the year 2000 are $602/month (U.S. Census Bureau, 2003), rent-free living constitutes a sizeable transfer. In another 15.0% of child-caregiver families, the parent has transferred ownership of her home to children (this number is 0.8% in formal-caregiver families). Median housing wealth for these families is $65,000. In our data, financial transfers to caregiving children are infrequent and small (the 90th percentile is merely $500 annually, including zeros) and so we are ignoring these cases in this category. Thus, substantial contemporaneous transfers to the child generation take place in 62.3% of child-caregiver families.

Potential bequest, no exchange: 25.3%. For another 25.3% of child-caregiver families, we find that there is no contemporaneous transfer, but that the child can expect a bequest. Most common is that the parent has housing wealth (11.6%, median housing wealth among these parents being $63,100). The second-most common case is that there is no housing wealth, but that the child is the beneficiary of life insurance (10.0%). Finally, the remainder of the potential-bequest group is made up by parents who have neither housing wealth nor life insurance but own substantial non-housing wealth (3.8%, median wealth being $70,400).

No measurable compensation: 12.6%. Only in 12.6% of child-caregiver families do we find neither contemporaneous exchange nor potential bequests. Our model will rationalize such behavior by altruism.

Table 8 in the Online Appendix compares transfers to children *within* child-caregiver families. We find that a heavy-helper child receives transfers (co-residence, home of parent, beneficiary of life insurance) much more frequently than her non-heavy-helper siblings.[21]

[20] Co-residence is very common: It takes place in 72.4% of child-caregiver families. It can also constitute a transfer from child to parent.

[21] In terms of realized bequests, Groneck (2015) finds caregiving children receive substantially higher bequests than non-caregiving siblings.

3 The model

We now build a quantitative dynamic model that is motivated by the stylized facts established in the previous section: (i) IC is a feasible choice for most elderly, but it entails large investments of time by the caregiver that are usually incompatible with full-time work, (ii) the vast majority of care goes to disabled elderly (i.e. those with more severe conditions), (iii) IC is usually concentrated on one caregiver: the spouse for the married, and a child for singles, (iv) IC is more likely the lower the opportunity cost of the child and the higher the wealth of the parent is, and (v) caregiving children receive compensation.

Time is continuous. The economy is populated by overlapping generations of individuals. The population grows at a constant rate g. An individual's age is denoted by j. Individuals work while $j \in [0, j_{ret})$ and then retire. Their maximum life span is $j_{dth} = 2j_{ret}$. An individual is a *kid* while $j \in [0, j_{ret})$ and a *parent* while $j \in [j_{ret}, j_{dth})$. Markets to insure against risk are absent; agents can use a savings technology with exogenous return r and face a no-borrowing constraint.

3.1 Families

3.1.1 Family structure

A *family* is made up of two decision units, or *agents*: a a *kid generation* (or just *kid*, indexed by k) of age $j^k \in [0, j_{ret})$ and a *parent generation* (or just *parent*, y p) of age $j^p = j^k + j_{ret}$. There is a continuum of families for each kid age $j^k \in [0, j_{ret})$ in the economy. In each family, the parent generation consists of one parent *household*, whereas the kid generation consists of a measure $(1 + \nu)$ of kid households. Consistency with the population growth rate requires $\nu = e^{g j_{ret}} - 1$. Each household (both parent and kid) consists of two *individuals*: one *female* and one *male* (unless members die, see Section 3.1.2).

3.1.2 Sources of uncertainty

Children only face uncertainty about their labor productivity. Parents face uncertainty about their health state, survival, and medical spending. Before describing the stochastic processes governing these risks, we establish some notation. A family's state is given by the vector $z \equiv (a^k, a^p, s, \epsilon^k, \epsilon^p, j^k)$. Here, $a^k \geq 0$ denotes the kid generation's wealth and $a^p \geq 0$ the parent's. $s \in \{0, 1\}$ is a binary health state: 0 means the parent is healthy, and 1 means the parent is in need of LTC.[22] ϵ^k and ϵ^p are productivity states from a set $E \equiv \{\epsilon_1, \ldots, \epsilon_{N_\epsilon}\}$.

For the kid, ϵ^k follows a Poisson process with age-independent hazard matrix $\delta_\epsilon = [\delta_\epsilon(\epsilon_i, \epsilon_j)]$.[23] The kid household's endowment in labor efficiency units is given by a mapping $y(j^k, \epsilon^k)$. Within each kid household, a fraction $\beta \in (0,1)$ of efficiency units pertain to the male and a fraction $(1-\beta)$ to the female. Once children retire and turn into parents, their productivity type stays fixed at the value that ϵ^k takes at j_{ret}. A parent household then receives an age-invariant pension flow, $y_p(\epsilon^p)$, per household member that is alive.

We now turn to health and mortality shocks. The parent starts out healthy ($s = 0$) at $j^p = j_{ret}$. At the hazard rate $\delta_s(j^p, \epsilon^p)$, the parent transitions into the LTC state ($s = 1$), which is absorbing. In both health states, $s \in \{0, 1\}$, the parent generation faces a mortality hazard, $\delta_d(j^p, \epsilon^p, s)$. Once the parent dies, all assets, a^p, are transfered to the child generation.[24] If still alive at age $j^p = j_{dth}$, the parent generations dies with certainty and bequeathes its assets to the kid. The kid generation then splits up into $(1+\nu)$ separate parent households, each with wealth $(a^p + a^k)/(1+\nu)$. Each of these new parent households keeps the productivity state it had when turning into a parent, ϵ^p, and is matched to a new kid with the same productivity as the parent, $\epsilon^k = \epsilon^p$, and zero wealth, $a^k = 0$.

We now turn to the composition of households within each generation. We assume that each kid household consists of $n^k = 2$ members, one male and one female. For parent households, we aim to capture three facts we observe in our data: Males typically have LTC needs before their spouses have, are outlived by their spouses, and obtain care mostly from their spouses. In order to economize on the number of states, we assume that parent households diminish deterministically in size. A parent household consists of $n^p(j^p, \epsilon^p, s)$ individuals. The n^p individuals in a parent household are made up of 1 female and a fraction $n^p - 1$ of male individuals. While healthy, $s = 0$, a measure $s_m(j^p, \epsilon^p)$ of males have LTC needs. An exogenous fraction $\iota \in [0, 1]$ of these males receive informal care from their spouse (at zero cost). The remaining fraction of men, $(1 - \iota)$, receive privately-paid care in a nursing home. Once the female has LTC needs, $s = 1$, we assume that the male in the household dies and only a widow is left, i.e. $n^p(\cdot, s = 1) = 1$. This state captures the (largely female) single population of disabled elderly

[22] The sick state in the model corresponds to individuals we classified as *disabled* in our empirical work, care amounting to at least a part-time job.

[23] A Poisson process is the continuous-time analog of a Markov process in discrete time. $\delta_\epsilon(\epsilon_i, \epsilon_j)$ is the hazard rate of transitioning from ϵ_i to ϵ_j, meaning that the probability of transitioning from state i to j is $\delta_\epsilon(\epsilon_i, \epsilon_j)\mathrm{d}j$ over an interval of infinitesimal length $\mathrm{d}j$. We define the diagonal elements of the hazard matrix as $h_\epsilon(\epsilon_i, \epsilon_i) = -\sum_{j \neq i} h_\epsilon(\epsilon_i, \epsilon_j)$ for notational convenience in the Bellman Equations.

[24] We do not model an estate tax since in the U.S. only the estates of the wealthiest 0.2% of households pay estate taxes, see Joint Committee on Taxation (2015).

that we are mainly interested in.

Finally, the parent (but not the child) faces medical-spending risk. At a hazard rate $\delta_m(j^p, \epsilon^p, s)$, a *medical event* occurs. Given a medical event, the parent household incurs a lump-sum medical cost M, which is drawn from the cdf $F_m(M)$.

3.1.3 Choices: Care, gifts, consumption, and savings

Parent healthy. While the parent is healthy, $s = 0$, households face a standard consumption-savings problem with the additional possibility of gifts.[25]. In each instant, both agents first decide on a non-negative gift flow, $\{g^i\}_{i\in\{k,p\}}$ (*gifts*, or *altruistically-motivated transfers*), to the other agent in this family, followed by the choice on a non-negative consumption flow, $\{c^i\}_{i\in\{k,p\}}$. Savings are then residually determined through the budget constraint.

Parent sick. A LTC parent ($s = 1$) has to either obtain *informal care* (IC) from the kid or formal care. The family's IC decision is denoted by $h \in \{0, 1\}$. When IC occurs, $h = 1$, the female in one of the kid households (the *marginal household*) does not supply labor to the market, and the parent can give a non-negative *exchange-motivated transfer* $Q \geq 0$ to the kid. Formal care can either be bought on the market at flow cost p_{bc} (*privately-paid care*, PP), or is paid for by the government through means-tested Medicaid (MA). We will describe the MA means test and the timing of care decisions in Section 3.1.5. The parent's MA decision is denoted by $m \in \{0, 1\}$.

3.1.4 Taxes and government transfers

The government levies a social-security payroll tax, τ_{ss}, on labor earnings. It also runs a progressive income-tax system, which works as follows. A household's taxable income, y_{tax} (the sum of labor and capital income) is taxed at rate $\tau(y_{tax})$, where $\tau(\cdot)$ is an increasing function. Social-Security (SS) benefits are not taxed. Tax payments of the parent household, T^p, and the kid households, T^k, depend on the state z and the IC decision h:

$$
\begin{aligned}
T^p(z) &= ra^p\tau(ra^p), \\
T^k(z,h) &= \tau_{ss}y_l + \big[(1-\tau_{ss})y_l + y_k\big]\tau\big((1-\tau_{ss})y_l + y_k\big), \\
\text{where} \quad & y_l = [1 - h(1-\beta)]wy(j^k, \epsilon^k), && \text{(labor income)} \\
& y_k = \frac{ra^k}{1+\nu}. && \text{(capital income)}
\end{aligned}
$$

[25]This is exactly as in Barczyk & Kredler (2014*a*)

Parents only pay taxes on asset returns but not on SS benefits. Kids pay SS contributions on labor income and income taxes.[26] Note that if $\tau(\cdot)$ is an increasing function (i.e. if income taxation is progressive), then this constitutes an implicit subsidy for IC since the kid household pays a lower tax rate if $h = 1$. It is understood in the above formula that $h = 0$ for the infra-marginal kid household.

Agents also receive government transfers for LTC and medical events. The child receives an IC subsidy flow, $s_{ic} \geq 0$, whenever IC occurs ($h = 1$). The parent receives a PP subsidy flow, $s_{pp} \geq 0$, whenever she is in PP care ($s = 1, h = m = 0$). The same subsidies are paid for the fractional disabled husbands in healthy families who receive IC and PP. Finally, the government pays a lump sum $M - a^p$ to the parent in case a medical shock exceeds her stock of wealth.[27]

3.1.5 Timing and the MA means test

We now describe the timing of decisions over an instant of time, which occurs in four *stages*.

Stage 1: Bargaining on IC. The family considers whether to undertake IC and what the exchange-motivated transfer $Q \geq 0$ should be in this case. If IC generates surplus for both parent and kid, IC takes place ($h = 1$). Q is pinned down through generalized Nash bargaining, where the kid has bargaining weight $\omega \in [0, 1]$.

Stage 2: Gift-giving. Next, kid and parent choose the gift flows $g^p \geq 0$ and $g^k \geq 0$ simultaneously. This is especially relevant if the family chooses formal care in Stage 1: Children can enable the parent to avoid Medicaid by helping to pay privately for a nursing home.[28]

Stage 3: Medicaid decision. In case the family has chosen formal care ($h = 0$), the parent decides if to opt for MA ($m = 1$) or for PP ($m = 0$). MA is free but means-tested: The elderly has to hand over to the government the entire stock of wealth, a^p, the pension flow, $y_p(\epsilon^p)$, and any gift flow, g^k, if she chooses MA. In MA, the parent receives a consumption floor C_{ma}; this floor includes any negative utility from MA, such as stigma effects and poorer quality of the nursing home.[29] If PP is chosen ($h = m = 0$), the parent pays the market price of nursing-home

[26] Recall that the kid generation consists of $(1 + \nu)$ households, thus the generation's capital earnings have to be divided by $(1 + \nu)$ to obtain capital earnings on the household level.

[27] This models a means-tested part of Medicaid that insures poor families against medical-spending shocks.

[28] Note that the sequencing matters here. If the gift-giving stage takes place after the Medicaid decision the parent can commit, at least over a short period of time, not to take advantage of the government's MA provision. But then, by staying out of MA, the parent can force the altruistic child to give transfers to the parent if her pension is not sufficient to pay for private care. We do not think that the elderly can credibly threaten to reject government aid and thus decided against this modeling strategy.

[29] We rule out that the kid gives gifts to the parent to lift her consumption level above C_{ma} in MA. The assumption is that the government only pays for basic care services, and that individuals have to accept this consumption

care, p_{bc}, and receives a subsidy flow from the government, s_{pp}. Unlike in MA, in PP the parent can freely decide consumption, c^p, and gifts, g^p. Following (Kopecky & Koreshkova 2014), we will interpret $p_{bc} + c^p$ as the parent's nursing-home expenditures. The fixed component p_{bc} captures the price of *basic care services*. The variable component c^p captures room and board and the amenities of the facility. This modeling strategy allows us to capture the fact that there is large variation in nursing-home quality and expenditures.

Stage 4: Consumption-savings decision. In the last decision stage, both generations simultaneously choose their consumption flows, c^p and c^k, and pay for them. Finally, both generations receive interest payments on their assets and collect utility. After this, the game moves on to the next instant.[30]

3.1.6 Preferences

Per-period *felicity* of the kid generation from the kid generation's consumption expenditure, c^k, is given by

$$u^k(c^k) = \frac{2(1+\nu)}{1-\gamma}\left(\frac{c^k}{(1+\nu)\phi(2)}\right)^{1-\gamma},$$

where $\gamma > 0$ is the parameter of relative risk aversion and $\phi(n) = 1+0.7(n-1)$ is an equivalence scale that adjusts consumption for household size.[31] The generation's consumption expenditure, c^k, is divided by the number of households, $(1+\nu)$, and the equivalence scale, $\phi(2)$, to obtain individual-level consumption. Individual flow felicity is then multiplied by the number of individuals, $2(1+\nu)$.

Similarly, per-period felicity for the parent generation is

$$u^p(c^p, h; z) = \frac{n^p(z)}{1-\gamma}\left(\frac{c^p - s(1-h)C_f}{\phi\big(n^p(z)\big)}\right)^{1-\gamma}$$

When healthy ($s = 0$) or when in IC ($h = 1$), this felicity functional is analogous to the kid's. When the parent receives formal care, however, the term involving the felicity penalty C_f becomes relevant. C_f is a parameter that governs the parent's preference for IC. The interpretation is that when in formal care, the parent requires C_f more units of consumption than in IC to be indifferent between the two scenarios. From survey evidence, we expect C_f to be positive—the

floor—they cannot opt for better conditions (e.g. a single room) by paying a higher price.

[30]We assume that there are no costs of switching between the different care arrangements, thus the care choice is not a state variable.

[31]See, for example, Bick & Choi (2013).

elderly typically say they prefer staying at home to going to a nursing home.[32] Note that our additive specification makes IC relatively more attractive for poor people. The higher a person's consumption level, the lower is the percentage increase in consumption required to make her prefer formal over informal care.

The kid generation's flow *utility* is $u^k(\cdot) + \alpha^k u^p(\cdot)$. The parent, while alive, has flow utility $u^p(\cdot) + \alpha^p u^k(\cdot)$. The parameters $\alpha^k, \alpha^p \in [0, 1]$ govern the strength of altruism. Once dead, the parent values the kid's felicity at α^p, the grandchild's felicity at $(\alpha^p)^2$, and so forth.[33] Future utility flows are discounted at rate $\rho > 0$ by all agents.

3.1.7 Flow budget constraints

Before we present the value functions that characterize the agents's problems recursively over the four stages of the instantaneous game, we present agents' flow budget constraint consolidated over the four stages of an instant. They show all potential revenues and outlays in one place and thus serve as a good summary of the physical environment.[34]

$$\begin{aligned}
\mathrm{d}a^k = \Big(& ra^k - c^k - g^k + g^p + (1+\nu)\big[y(j^k, \epsilon^k) - T^k(z, 0)\big] \\
& + sh\big[Q + s_{ic} - (1-\beta)y(j^k, \epsilon^k) - T^k(z, 1) + T^k(z, 0)\big] \Big)\mathrm{d}j,
\end{aligned} \tag{1}$$

$$\mathrm{d}a^p = \begin{cases} \Big(ra^p - c^p + g^k - g^p + y_p(\epsilon^p) - T^p(z) - shQ - s(1-h)(p_{bc} - s_{pp}) \\ \quad +(1-s)s_m\big[\iota s_{ic} - (1-\iota)(p_{bc} - s_{pp})\big] \Big)\mathrm{d}j - \min\{M, a^p\} & \text{if } m = 0, \\ -a^p & \text{if } m = 1. \end{cases} \tag{2}$$

If parents are healthy ($s = 0$) or care is formal ($h = 0$), kids receive flow income from savings, ra^k, and the $(1 + \nu)$ households' labor earnings, $y(j^k, \epsilon^k)$. They pay taxes on these earnings, consume, and they may give and receive gifts. When the marginal kid household gives IC ($s = h = 1$), then there is an inflow of transfers from parent and government, $Q + s_{ic}$, but also an opportunity cost from lost labor income, $(1 - \beta)y(\cdot)$, which is again partially offset by a reduction in tax payments.

Note that all changes to the kid's wealth are *flows* (they are all multiplied by $\mathrm{d}j$), whereas

[32] According to the survey *Aging in Place* (2011), 90% of seniors say they want to stay in their home as long as possible.

[33] This is standard in the literature on altruism and gives rise to a simple recursive formulation for value functions.

[34] These budget constraints are only valid while the death shock does not hit the parent. In the case this shock hits, an additional (lump-sum) term $+a^p$ appears in the kid's budget constraint; the parent agent disappears.

the parent's wealth may decrease by a lump sum. Such lump-sum payments may occur for two reasons: medical-spending shocks, M, and Medicaid uptake ($m = 1$). The remaining items on the parent's budget constraint are flows, most of which are familiar from the kid's constraint. The parent pays Q to the kid in case of informal care ($s = h = 1$), she pays $(p_{bc} - s_{pp})$ for care in a nursing home in the case of PP ($s = 1, h = 0$), and she has outlays and subsidy income for the measure s_m of disabled husbands who are residing in the household when she is healthy ($s = 0$).

3.1.8 Agents' problems

Agents' decision problems are characterized by Hamilton-Jacobi-Bellman equations (HJB). The value functions V^k and V^p satisfy the HJBs

$$\rho V^i(z) = V^i_{j^k}(z) + J^i + H^{i,1}(z; \underbrace{V^p_{a^p}, V^p_{a^k}, V^k_{a^p}, V^k_{a^k}}_{\equiv V_a}), \qquad i \in \{k, p\}, \tag{3}$$

where subscripts to V^i denote partial derivatives. J^i stands for a series of jump terms that encode stochasticity of productivity, medical-spending, health, and death. Appendix A.2 gives the definition of J^i and other details on the HJBs. $\{H^{i,1}(\cdot)\}_{i=k,p}$ are Hamiltonian functions that take the state, z, and the vector of partial derivatives, V_a, as arguments. Equation (3) is thus a first-order partial differential equation (PDE). We now derive the Hamiltonian functions $\{H^{i,1}(\cdot)\}_{i=k,p}$ by backward induction on the stages of the instantaneous game. We do this for the general case when the parent is sick; only Stages 2 and 4 are relevant when the parent is healthy. Let $H^{i,n}(\cdot)$ denote the Hamiltonian of player i in the n'th stage of the game. Also, let $y_{i,n}$ denotes player i's stage-n flow-income-on-hand, which is determined by decisions in the stages before n. We also define the vector $y_n \equiv [y_{k,n}, y_{p,n}]$.[35]

Stage 4: Consumption-savings decision. Given the IC decision, h, the MA decision, m, and Stage-4 incomes, y_4, both players optimally trade off instantaneous felicity and the marginal

[35] Since time is continuous, stocks and flows have to be treated separately and we cannot lump flow incomes, y_n, and wealth stocks, $\{a^i\}_{i\in\{k,p\}}$ into a single cash-on-hand variable as in discrete time.

value of savings:

$$H^{k,4}(z,V_a;y_4,h,m) = \max_{c^k\in\mathbb{C}^k}\left\{\alpha^k u^p(c^p,h;z) + u^k(c^k) + \dot{a}^p V^k_{a^p} + \dot{a}^k V^k_{a^k}\right\}, \tag{4}$$

$$H^{p,4}(z,V_a;y_4,h,m) = \max_{c^p\in\mathbb{C}^p}\left\{u^p(c^p,h;z) + \alpha^p u^k(c^k) + \dot{a}^p V^p_{a^p} + \dot{a}^k V^p_{a^k}\right\}, \tag{5}$$

$$\text{where} \qquad \mathbb{C}^i = \begin{cases}[0,\infty) & \text{if } a^i > 0,\\ \{C_{ma}\} & \text{if } i = p \text{ and } m = 1,\\ [0, y_{i,4}] & \text{otherwise,}\end{cases}$$

$$\dot{a}^i = y_{i,4} - c^i \qquad \text{for } i \in \{k,p\}.$$

Note that consumption cannot exceed flow income once wealth is depleted ($a^i = 0$), in which case the agent may be constrained. Parents in MA are bound to consume the consumption floor.[36]

Stage 3: Medicaid decision. 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. To see this, note that the parent could always delay MA by an instant, buy PP instead, and choose consumption $c^p > C_{ma}$. This strategy obviously yields a higher utility flow and higher assets (and thus more future options) after an instant $\mathrm{d}j$ than handing in a positive stock of wealth to the government. Given the IC decision, h, and Stage-3 incomes, y_3, the Stage-3 Hamiltonians are

$$\begin{aligned} H^{i,3}(z,V_a;y_3,h) = {} & mH^{i,4}(z,V_a;[y_{k,3},C_{ma}],0,1) \\ & + (1-m)H^{i,4}(z,V_a;[y_{k,3},y_{p,3}-p_{bc}+s_{pp}],h,0), \qquad \text{for } i\in\{k,p\}, \end{aligned} \tag{6}$$

$$\text{where} \qquad m = \begin{cases} 1 & \text{if } s = 1 \text{ and } h = 0 \text{ and } a^p = 0 \text{ and} \\ & H^{p,4}(\cdot;[y_{k,3},C_{ma}],0,1) > H^{p,4}(\cdot;[y_{k,3},y_{p,3}-p_{bc}+s_{pp}],0,0), \\ 0 & \text{otherwise.}\end{cases}$$

The second equation gives the optimal MA decision. This decision is relevant only if the game arrives at the formal-care node, $s = 1$ and $h = 0$, and the parent is broke, $a^p = 0$. The parent chooses MA if the value from doing so in the Stage 3 is higher than that of choosing PP. In MA, the means-test implies the parent enters the next stage with income-on-hand C_{ma}. In PP care, the parent has to pay the price of a nursing home minus the government subsidy.

[36] We allow for $y_{p,4} < 0$. In this case we set $\mathbb{C}^p = \varnothing$ and $H^p_4 = -\infty$.

Stage 2: Gift-giving. Given the IC decision, h, and Stage-2 incomes, y_2, the Stage-3 Hamiltonians are

$$H^{k,2}(z, V_a; y_2, h) = \max_{g^k \in \mathbb{G}^k} H^{k,3}(z, V_a; [y_{k,2} + g^p - g^k, y_{p,2} - g^p + g^k], h), \tag{7}$$

$$H^{p,2}(z, V_a; y_2, h) = \max_{g^p \in \mathbb{G}^p} H^{p,3}(z, V_a; [y_{k,2} + g^p - g^k, y_{p,2} - g^p + g^k], h), \tag{8}$$

$$\text{where} \qquad \mathbb{G}^i = \begin{cases} [0, \infty) & \text{if } a^i > 0, \\ \{0\} & \text{if } i = p \text{ and } s = 1 \text{ and } h = 0 \text{ and } a^p = 0, \\ [0, y_{i,2}] & \text{otherwise.} \end{cases}$$

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.[37]

Stage 1: Bargaining on informal care. Given the state, z, and value-function derivatives, V_A, the Stage-1 Hamiltonians are

$$H^{i,1}(z, V_a) = H^{i,2}\big(z, V_a; [(1-h)y_{k,fc} + h(y_{k,ic} + Q^*), y_{p,1} - Q^*], h\big) \quad \text{for } i \in \{k, p\}, \tag{9}$$

$$\text{where} \quad y_{p,1} = ra^p + y_p(\epsilon^p) - T^p(z) + (1-s)s_m[\iota s_{ic} - (1-\iota)(p_{bc} - s_{pp})],$$

$$y_{k,fc} = ra^k + (1+\nu)[y(j^k, \epsilon^k) - T^k(z, 0)],$$

$$y_{k,ic} = ra^k + (1+\nu-\beta)y(j^k, \epsilon^k) - T^k(z, 1) - \nu T^k(z, 0) + s_{ic},$$

$$h = \begin{cases} 1 & \text{if } s = 1 \text{ and } \exists\, Q \geq 0 \text{ s.t. } S^p(Q) \geq 0 \text{ and } S^k(Q) \geq 0, \\ 0 & \text{otherwise,} \end{cases} \tag{10}$$

$$\text{where } S^i(Q) = H^{i,2}\big(z, V_a; [y_{k,ic} + Q, y_{p,1} - Q], 1\big) - H^{i,2}\big(z, V_a; [y_{k,fc}, y_{p,1}], 0\big), \tag{11}$$

$$\text{and} \qquad Q^* = \begin{cases} \arg\max_{Q \geq 0} \left\{ [S^k(Q)]^\omega [S^p(Q)]^{1-\omega} \right\} & \text{if } h = 1, \\ 0 & \text{otherwise.} \end{cases} \tag{12}$$

Informal care is provided to a sick parent if there exists a non-negative transfer Q such that both players' surplus is positive. The surplus is the difference between the Hamiltonians, $\{H^{i,2}\}_{i \in \{k,p\}}$, under the IC scenario and the formal-care scenario in Stage 2. For the parent, under IC the

[37] This is not a strong assumption. For Medicaid recipients, the government has control on their SS benefits, making gifts to children impossible for a parent who has no wealth. Also for elderly in PP, gift-giving is almost impossible for parents without wealth – private nursing homes are expensive in the U.S., and usually exceed SS benefits by far. We could allow for gift-giving also by parents with zero wealth in formal care without changing our results, but at the cost of including g^p into the state at the point where MA is chosen.

Stage-2 income is Q lower than in formal care since she has to pay the transfer. The kid receives the transfer Q only under IC. But there is also a difference in income due to labor supply (it is $y_{k,ic}$ for $h = 1$, but $y_{k,fc}$ for $h = 0$). Gross labor income is lower in IC since the marginal caregiver does not work. On the other hand, the kid receives the IC subsidy, s_{ic}, and pays lower income taxes, T^k. Finally, if IC takes place, the equilibrium transfer Q^* is determined such that it maximizes the Nash-bargaining criterion in (12).

3.2 Firms

There are two market goods that are produced by competitive firms: a consumption good, y, and formal (or nursing-home) care, f. The representative firm in the consumption-goods sector chooses the labor input L_y to solve the profit-maximization problem

$$\max_{L_y \geq 0} \left\{ A_y L_y - w L_y \right\}, \tag{13}$$

where $A_y > 0$ is productivity in the consumption-goods sector and w is the wage rate. For the formal-care sector, we assume that nursing-home slots providing basic care services are produced using only labor. The representative nursing home's problem is

$$\max_{L_f \geq 0} \left\{ p_{bc} A_f L_f - w L_f \right\}, \tag{14}$$

where $A_f > 0$ is productivity in the nursing-home sector and p_{bc} is the market price of basic care services. Perfect competition implies that in equilibrium profits are zero in both sectors. Equations (13) and (14) thus imply that equilibrium prices are

$$w = A_y, \qquad\qquad p_{bc} = \frac{A_y}{A_f}. \tag{15}$$

3.3 Government

The government purchases basic care services in the formal-care market at price p_{bc} and spends y_{ma} consumption goods per nursing home slot. Thus, the total MA reimbursement rate is $p_{bc} + y_{ma}$ (per MA recipient). MA nursing-home patients receive a consumption flow C_{ma}.[38]

The government runs a balanced budget in each instant. It collects payroll taxes on labor

[38] We allow for $C_{ma} < y_{ma}$; this captures that there may be stigma effects of Medicaid and/or that the government sector provides care inefficiently.

income and taxes income from labor and capital. From these revenues, it pays social-security benefits, MA nursing-home slots, subsidies for IC and PP care, means-tested benefits for medical expenditures, and a fixed level of other government consumption. See Appendix A.1 for the detailed budget constraint.

3.4 Equilibrium

We adopt a standard recursive equilibrium definition. Parents and kids are best-responding to each other, being restricted to Markovian strategies. The government balances its budget in steady state, i.e. under the ergodic measure of families over the state space. Firms make zero profits and markets clear. See the appendix for the detailed equilibrium definition.

3.5 Characterizing the IC choice

We no characterize the decisions regarding care arrangements and exchange-motivated transfers, gifts, consumption, and savings, using backward induction on the instantaneous game between kids and parents taking as given the value functions and their partial derivatives. In this section, we will focus on the key modeling innovation of this paper: the determination of IC in a dynamic setting (Stage 1 of the game). The intuition behind this choice is best understood in the special case in which both parent and child have positive wealth. We thus concentrate on this case here. We provide a general characterization of the IC decision in Proposition A.1 in Section A.6 of the Appendix. The characterization of the other stages of the game is in Section A.4 of the Appendix.

In order to obtain the family's IC decision, we obtain the surplus functions $S^i(Q)$, $i \in \{k, p\}$, from IC as the difference between the Hamiltonians under the scenario that IC takes place and that it doesn't for an arbitrary transfer $Q \geq 0$, see Equation (11). In the special case where both agents have positive wealth, the surplus functions turn out to be linear in Q and we can back out cut-off values for IC and the equilibrium transfer in closed form.[39]

Proposition 3.1 (IC cut-off values) *Consider z such that $a^k > 0$, $a^p > 0$, $s = 1$, and suppose that $V^k_{a^k}(z) > V^k_{a^p}(z)$, $V^p_{a^p}(z) > V^p_{a^p}(z)$, and $m(z) = 0$. The parent's* willingness to pay for informal care *at z, i.e. the highest Q the parent is willing pay to stay at home, is*

$$\bar{Q}^p(z) = \frac{(C_f + p_{bc} - s_{pp})V^p_{a^p}(z) - (\Delta y_{ic} - s_{ic})V^p_{a^k}(z)}{V^p_{a^p}(z) - V^p_{a^k}(z)}, \tag{16}$$

[39]Proofs for the following two propositions are provided in Appendix A.5.

where $\Delta y_{ic} \equiv y_{k,fc} - y_{k,ic}$ *is the net-income loss the kid experiences when giving IC. The* reservation transfer *for the kid generation, i.e. the lowest Q for which the kid is willing to provide IC at* z*, is*

$$\underline{Q}^k(z) = \frac{(\Delta y_{ic} - s_{ic})V^k_{a^k}(z) - (C_f + p_{bc} - s_{pp})V^k_{a^p}(z)}{V^k_{a^k}(z) - V^k_{a^p}(z)}. \tag{17}$$

Since agents will value both their own and the other agent's wealth positively in equilibrium, i.e. $V^i_{a^j} > 0$ for $i, j \in \{k, p\}$, and since $V^i_{a^i} > V^i_{a^j}$ for $i \neq j$, we can deduce the following comparative statics from (16) and (17). The parent's willingness to pay for IC is increasing in the price of formal care, p_{bc}, her preference for informal care, C_f, and the IC subsidy, s_{ic}. The richer the parent, the lower the marginal value of wealth, $V^p_{a^p}$, becomes, and the less is preference for informal care, C_f, matters. The parent's willingness to pay is decreasing in the PP subsidy, s_{pp}, and the kid's opportunity cost, Δy_{ic}. The more altruistic the parent is, the more will she value the kid's wealth, i.e. the higher $V^p_{a^k}$ will be. Thus a more altruistic parent will be willing to give higher transfers.

The kid's reservation transfer is a mirror image of the parent's willingness to pay. It is increasing in the kid's opportunity cost and the PP subsidy, and it is decreasing in the IC subsidy, the price of formal care, and the parent's preference for IC. The more altruistic the kid, the higher we expect $V^k_{a^p}$ to be; thus a more altruistic kid will take into account the parent's utility loss C_f in PP to a larger extent. But note that $V^k_{a^p}$ encodes not only altruistic considerations, but also the (purely selfish) consideration of the kid that a richer parent will leave a higher bequest. Quantitatively, we find that the term $p_{bc}V^k_{a^p}$, which encodes the child's desire to protect the parent's wealth from being spent on nursing-home fees, is key for kids to provide IC at low or even zero transfers.

Proposition 3.2 (IC choice and exchange-motivated transfers) *Consider* z *such that* $a^k > 0$*,* $a^p > 0$*,* $s = 1$*, and suppose that* $V^k_{a^k}(z) > V^k_{a^p}(z)$ *and* $V^p_{a^p}(z) > V^p_{a^p}(z)$*. Then the care arrangement satisfies*

$$h(z) = \mathbb{I}\{\bar{Q}^p(z) \geq \underline{Q}^k(z)\},$$
$$Q^*(z) = \max\left\{0, (1-\omega)\underline{Q}^k(z) + \omega\bar{Q}^p(z)\right\}.$$

Taking together Proposition 3.2 and the thresholds from (16) and (17), we conclude that informal care is more likely, and the transfer Q^* is higher, (i) the more the old values informal care (the higher C_f), (ii) the more expensive formal care is (the higher $p_{bc} - s_{pp}$), (iii) the lower the child's opportunity cost is (the lower Δy_{ic}), and (iv) the more the child values the parent's wealth (the higher $V^k_{a^p}$), be it due to altruism or bequest considerations.

The cases in which one or both agents have zero wealth are more cumbersome to characterize. We will illustrate these cases below using figures generated from the numerical solution of the model.

3.6 Numerical solution: Dynamics and care arrangements

We solve for the equilibrium of the game between parents and kids numerically by backward-iterating jointly on the value functions of the parent and the kid in age. For this, we use the characterizations of care decisions from the previous section and combine them with the Markov-chain approximation algorithm from Barczyk & Kredler (2014*a*) for the consumption-savings and gift-giving decisions.[40] Given the equilibrium laws of motion, we then forward-iterate in age to find the ergodic measure of families over the state space, using the same techniques. Appendix A.7 gives the details.

Figure 1 illustrates typical care arrangements and dynamics of the model (these are generated for parent age 80, using the calibrated model discussed next). The various care arrangements are represented by different shades of grey as a function of (a^p, a^k), given different productivity levels of parent and kid in the sub-figures. The wealth dynamics, $(\dot{a}^p, \dot{a}^k)$, are represented by arrows.

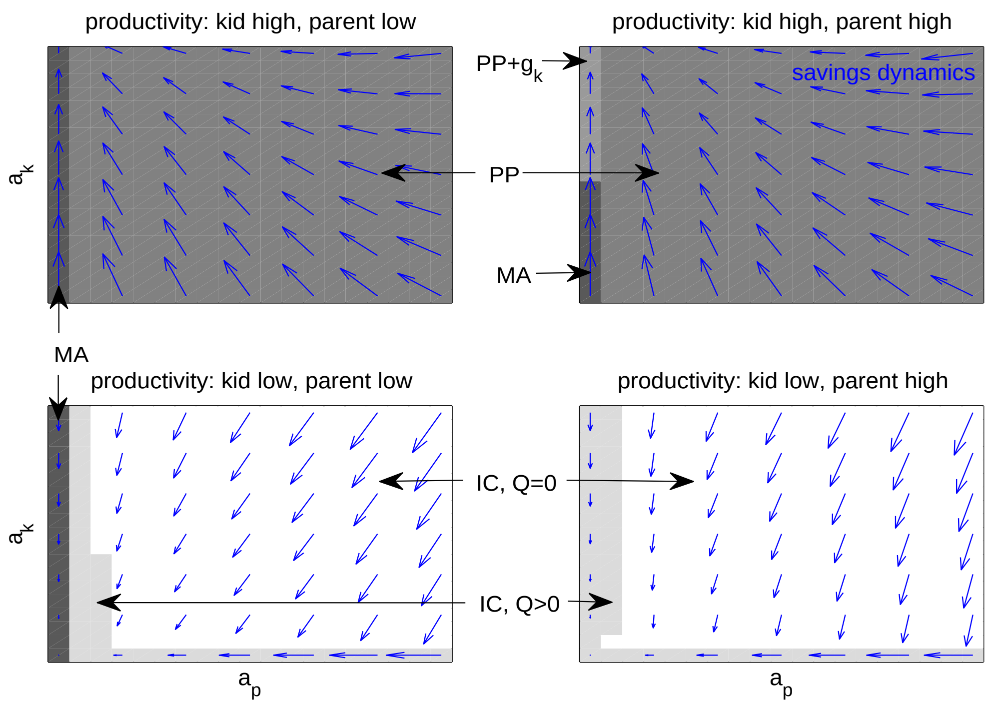
Consumption-savings behavior. Kids engage in precautionary-savings behavior and save when their income is high – all arrows point upward in the upper figures. Kids dis-save when income is low to smooth consumption. Parents' pension is deterministic and because they are already in need of LTC they dis-save in order to smooth their consumption (all arrows point to the left).

Care arrangements. In families with high-opportunity-cost kids, IC never takes place, no matter how wealthy the parent is. Instead, the parent relies on PP care – at least as long as she has wealth. Once she spends down her wealth she either comes to rely on MA if her pension is too low; or –despite a low pension– continues in PP care if kids are wealthy enough to support her financially with gifts (region $PP + g^k$).

When kids' opportunity costs are low (the lower two figures), IC takes place whether the parent's pension is high or low, so long as the parent owns wealth. When the parent exhausts

[40] This Markov-chain approximation method can also be cast as a classical finite-element solution techniques for PDEs. It discretizes continuous states (wealth and age) and uses finite approximations of the value function derivatives to update the value function.

Figure 1: Care choices and savings dynamics



Snapshot of state space at parent age 80 in calibrated model. Kid productivity: *high* is the top grid point (out of 7 grid points), *low* is the third-lowest grid point. Parent productivity: *high* is top grid point (out of 7), *low* is bottom grid point. Arrows depict law of motion of family wealth $(\dot{a}^p, \dot{a}^k)$. Shaded regions correspond to care regions: IC without transfers (IC, $Q = 0$) = white; IC with transfers (IC, $Q > 0$) = light grey; PP care plus financial support from children (PP+ g^k) = medium grey; PP care without kid support (PC) = dark grey; Medicaid (MA)=black.

her wealth and her pension is high, she continues to receive IC because she still has enough to offer in exchange for care; with a low pension, however, the parent makes use of MA. Since kids are relatively income-poor in this case, they do not provide financial support for paying a nursing home but rather give IC. When the parent has sufficient wealth, then the expectation of a bequest is enough to motivate the kid to give care, and there is no contemporaneous transfer (IC, $Q = 0$). When the parent has low wealth, however, contemporaneous transfers flow (IC, $Q > 0$). Transfers are also positive when the kid is broke, since the parent wants to prop up the kid's consumption; there is an altruistic component to Q then. The model also generates regions in which kids give purely altruistic care (IC with $Q = 0$ to parents with $a^p = 0$), but these are uncommon in our calibration since the kid's altruism is low and do not show up in the figure.

4 Calibration

We calibrate our model to the US economy in the year 2000. We first describe how we choose parameters pertaining to demography, health and other risks, technology, and the government. We estimate these parameters directly from the data or take them from the literature. We then describe how we identify preference parameters and the bargaining weight jointly by matching model-generated moments to their data counterparts. Finally, we evaluate the model fit in non-targeted dimensions and discuss implications of our calibration.

4.1 Demography, shocks, technology, and government

Demography. We set model age 0 to be equivalent to age 35 in the data. Individuals retire at model age $j_{ret} = 30$ (data age 65); certain age of death is $j_{dth} = 60$ (data age 95). We set $\nu = 0.5$, i.e. the kid generation per parent has three members, corresponding to the average number of children of this cohort (see Wattenberg, 1984). This is also in line with the number of children in our HRS data.[41]

Labor productivity. We assume that efficiency units of labor have the following (standard) functional form in age and productivity:

$$\log[y(j,\epsilon)] = \beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 j^3 + \sigma_\epsilon \epsilon,$$

We estimate the coefficients for the age profile using the year 2000 US Census data for individual full-time workers, which yields $\sigma_\epsilon = 0.78$. We discretize ϵ on a grid with $N_\epsilon = 7$ values using methods equivalent to those suggested by Tauchen (1986) for discrete-time processes, using an annual autocorrelation coefficient of $\rho_\epsilon = 0.95$, a standard number in the literature. In our setting, ρ_ϵ also governs the correlation of parent's and kid's productivity. Our choice implies that at age 50, a typical age for child caregivers, the correlation coefficient between kid's and parent's productivity is 0.46, which lines up quite well with estimates on the inter-generational

[41] A shortcoming of our framework is that we can only handle two generations per family, i.e. parents and children (but no grandchildren), due to the difficulty that strategic interactions present. The way we choose the initial ages, initial parent age 65 and initial kid age 35, reflects a compromise we make between a proper demographic structure and a clean, self-contained model. For example, we could have added an additional life-cycle stage for agents of ages between 20 and 35, who are contemporaneously independent of other decision makers, and match them iid randomly with parent households at age 35. This, however, would lead to an empirically implausible correlation structure of productivities within the family, which plays a central role in the model. The downside of our approach is that wealth at age 35 cannot be endogenously generated. We opt to start agents off without wealth. We do this so that in the counterfactual policy experiments wealth responds entirely endogenously.

correlation coefficient of (log) lifetime incomes, which are around 0.4 (see the survey by Solon, 1999, section 4.2). We set β, the fraction of efficiency units pertaining to the male household member, equal to the male earnings share in married-couple families in the data; for the year 2000 this fraction is 0.66 (U.S. Bureau of Labor Statistics, 2013).

LTC risk and mortality. We obtain estimates for the LTC hazard, $\delta_s(j^p, \epsilon^p)$ and the mortality hazard, $\delta_d(j^p, \epsilon^p, s)$, from our HRS data. For our estimations, we use logistic regressions on females only. The regressions include a polynomial in age and interaction terms of age with education.[42] Mortality hazards also depend on the health state of the individual. We use a likelihood-ratio criterion to determine the preferred specification.

We classify an individual as LTC-dependent if they receive more than 90 monthly hours of care. Using this variable, we can estimate $\delta_d(\cdot)$ using a logistic hazard model with the covariates described above. A complication we face when estimating the LTC transition hazard is the following. In the model the LTC state is absorbing, whereas in the data –while not the norm– some individuals return from LTC to the healthy state. Our strategy to deal with this issue is to first estimate the fraction of LTC individuals, $\lambda(j^p, \delta^p)$, conditional on age and education with a logistic regression. We then back out the hazard function $\delta_s(\cdot)$ that, given the estimated death hazards $\delta_s(\cdot)$ and the assumption that LTC is absorbing, delivers the observed fraction $\lambda(\cdot)$ of LTC cases for each (j^p, ϵ^p) by solving a system of differential equations.

Appendix Section B.1 provides further details on this procedure, shows the implied life expectancies and expected LTC durations, and gives the hazard functions. Consistent with the literature, we find that female and high-education individuals live longer. Low-education individuals tend to become LTC-dependent at lower ages, when death hazards are relatively low. On expectation, they thus spend more years in disability than high-education individuals (both unconditionally and conditional on entry into disability).

Husbands. In order to pin down $n^p(\cdot)$, which determines the number of men in parent households, we proceed as follows. We estimate the number of surviving men above age 68 as a function of age and education. Assuming that the age gap is 3 years in all couples, we then set $n^p(j^p, \epsilon^k, s = 0)$ such that we exactly match the number of men in each age-education combination in the population.

For care arrangements in couples, we proceed as follows. We first estimate the fraction of disabled married individuals by age and education. We then choose $s_m(j^p, \epsilon^p)$ such that the

[42]We consider education since it is a fixed characteristic whereas SS benefits vary with widowhood status. We map productivity, ϵ^p, in the model to education in the data as follows. We measure the fraction of elderly females with high school (q_{hs}) and some college (q_{sc}). We then assign the q_{hs} lowest ϵ^p-values in the model to high-school, the q_{sc} next-lowest to some college, etc.

total number of disabled men in the model matches the number of disabled married individuals for each age-education cell. We determine ι from the fraction of disabled husbands who receive IC, which in our data is 85%.

Medical expenditures. We follow Kopecky & Koreshkova (2014) to estimate a post-Medicare and pre-Medicaid out-of-pocket (OOP) medical-expenditure shock process, excluding LTC costs. For this, we use the HRS and its exit interviews. We choose a log-normal form for the distribution of payments conditional on an event, $F_m(M)$, and back out its parameters from the expenditures of individuals who had exactly one medical event. We then estimate $\delta_m(j^p, \epsilon^p)$ from the number of events occurring to an individual.

Technology and nursing homes. We measure the consumption good y in dollars of year-2000 output. We define one efficiency unit of labor as the amount required to produce one unit of y in 2000, i.e. we normalize A_y to 1. In order to calibrate productivity in the formal-care sector, A_f, we need an estimate on how much a typical nursing home spends on basic care services. From the Minnesota Office of the Legislative Auditor (1995), we find that the fraction ψ of spending on care (wages, payroll taxes, administrative costs) in a nursing home accounts for 56.2% of total costs. Assuming that Medicaid only pays for basic care we calibrate the price for basic care services in a nursing home, p_{bc}, as ψ times the average annual Medicaid reimbursement rate $p_{bc} + y_{ma}$ of \$38,500, which we take from Stewart et al. (2009). Thus, we obtain $p_{bc} = \$21,640$ and $A_f = (21,640)^{-1}$, using the equilibrium price from Equation (15) to infer the latter. The return to the savings technology is set to $r = 0.02$, which is standard in the literature.

Government. Taxation of joint household income is based on the tax function by Gouvieia & Strauss (1994), and the Social Security benefit schedule is taken from Kopecky & Koreshkova (2014). The calibration of the MA reimbursement rate $p_{bc} + y_{ma}$ was discussed above. Subsidies s_{ic} and s_{pp} are zero in the baseline calibration. Other government spending is residually determined after paying for LTC and medical expenditures. When changing policies in the counterfactuals, they are paid for by a uniform increase to the income-tax schedule, i.e. we determine the tax change $\Delta\tau$ such that the new income-tax schedule, $\tilde{\tau}(y) = \tau(y) + \Delta\tau$, makes the government budget constraint hold in steady state.

4.2 Preferences and bargaining weight

We set the coefficient of relative risk aversion γ to 3.8. We take this estimate from DeNardi et al. (2010), who can generate realistic savings behavior in retirement using this parameter.

This makes our results comparable to the literature.

The remaining parameters are obtained by matching moments generated by the model to their counterparts in the data.

We identify the discount rate ρ by matching the median wealth of parents aged 70-75 in the model to the median net worth of households of the same age in the data. We choose this age range because we deem it important that the model generates the right amount of wealth around the time LTC risk becomes substantial, but when most individuals are still alive.

We pin down the consumption penalty for formal care, C_f, and the MA consumption floor, C_{ma}, by targeting the percentage of IC recipients and the ratio of total PP to MA spending on nursing homes.[43] We target aggregate spending instead of the percentage of MA recipients since there are many mixed forms between MA and PP in our data and since getting public LTC spending right is a priority for us.[44] Our PP-to-MA ratio is taken from data for the year 1997 from the HCFA Office of the Actuary, National Health Expenditures, Giacalone (2001). We adjust them to the year 2000 using data on price growth in the nursing-home sector given by Stewart et al. (2009).

We identify parental altruism, α^p, by using the average gift from healthy parents to the kid generation. We include also zero transfers, thus covering both the intensive and extensive margin. We leave out sick parents, since in our model these can also give transfers for exchange-motivated reasons (while for healthy parents they can only be due to altruism).

In order to pin down kid's altruism, α^k, we use the average gift the kid generation gives to a parent residing in a nursing home. Again, such transfers can only flow due to altruism in our model. We prefer this moment over transfers flowing from kids to healthy parents – the latter are quite rare in the data, so we worry that we identify altruism of a very select group of individuals.

Finally, the kid's bargaining weight, ω, is calibrated in order to match the mean transfer

[43] Recall that an individual who receives a mix of FHC and IC is counted as an IC recipient if and only if she receives more than half of her hours of care from informal sources. Individuals in the community who receive mainly FHC are thus represented as formal-care recipients (either PP or MA) in our calibration. Note that these individuals are not represented in the PP-to-MA spending ratio on *nursing homes*. We use the ratio on nursing-home spending since we have good data on aggregate expenditures on nursing homes, but not for community residents. One may worry that FHC individuals are almost always PP and thus our measure overstates MA usage. However, we find that among widow(er)/single disabled FHC individuals, 46.9% are MA supported, with median out-of-pocket expenditure of only $1,000 annually. This coverage is very similar to MA coverage in the nursing-home population, see Table 6, suggesting that the nursing-home statistics represent the overall formal-care population well.

[44] A further advantage of using aggregate LTC expenditure data is the heterogeneity in MA reimbursement rates across states and individuals.

by parents to caregiving children in the data, \$9,878. To compute this number, we take the weighted average of the imputed value of rent-free living and the per-annum value of housing assets transferred to kids, the weights on the two categories coming from our data in Section 2.6.[45]

4.3 Results

Table 4 presents the calibration results. The fit to the targeted moments is exact. The calibrated discount rate is high; given the high coefficient of relative risk aversion, low patience is necessary to rationalize the observed savings. Our estimate of the consumption floor is in the ballpark of estimates in the literature, but lies above DeNardi et al. (2010)'s estimate of \$2,700 (in 1998 dollars). This is explained by the introduction of the family-insurance channel in our model. In order to generate enough Medicaid uptake in the presence of this additional option, the consumption floor has to become more generous. Our estimate for the formal-care consumption penalty, C_f, means that a PP nursing-home resident has to incur a cost of \$4,050 before an additional dollar begins to yield the same utility as when receiving IC at home. This is consistent with survey evidence that the elderly typically want to stay at home for as long as possible.

The estimate for the parent's altruism is high. In conjunction with the curvature on the utility function, it means that a parent chooses a consumption ratio $c^k/c^p = (\alpha^p)^{1/\gamma} = 0.82$ when giving gifts to the child.[46] This high value also implies that the parent has a strong bequest motive. For the kid, the equivalent measure is a lot lower: $c^p/c^k = (\alpha^k)^{1/\gamma} = 0.12$. Finally, we see that almost all bargaining power has to be assigned to the parent in order for the model to generate the exchange-motivated transfers observed in the data. This will imply that many kids in our model will be motivated by expected bequests.

4.4 Model fit

We now evaluate the fit of the model in dimensions that were not targeted.

[45] We impute yearly rent from median gross rents in the US in the year 2000 of \$602/month (U.S. Census Bureau, 2003). The average home value of single parents with heavy-helper children is \$86,300 in our data, excluding the top 1% of this group. The expected duration of LTC in our model is 2 years and so to obtain a yearly home-transfer value we divide the home value by two. The mean exchange transfer is then imputed to be 47.3% of \$7,200 plus 15.0% of \$43,150.

[46] ...that is, when healthy and both households have the same size. This measure of altruism is proposed by Barczyk & Kredler (2014*a*).

Table 4: Calibration

γ	r	ρ^{ϵ}	ν	β	$p_{bc} + y_{ma}$	ψ	A_y	A_f	ι
3.8	2%	0.95	0.5	2/3	$38,500	56.2%	1	$(21.64)^{-1}$	0.85

Parameters calibrated outside of model. γ, coefficient of relative risk aversion based on DeNardi et al. (2010). r, interest rate, and ρ^{ϵ}, auto-correlation of efficiency units standard values. ν, measure of infra-marginal child households chosen to yield three children per parent household. β, male contribution to household income, based on U.S. Bureau of Labor Statistics (2013). $p_{bc} + y_{ma}$, annual average Medicaid reimbursement based on National Nursing Home Survey taken from Stewart et al. (2009). ψ, percentage of nursing home costs due to care from Minnesota Office of the Legislative Auditor (1995). A_y is goods-sector productivity (normalization) and A_f is formal-care-sector productivity, $(\psi(p_{bc} + y_{ma}))^{-1}$. ι, is the fraction among married LTC husbands who obtain informal care.

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

Authors' own estimates for efficiency units of labor, LTC risk and mortality, and medical expenditures excluding LTC costs; see main text for details.

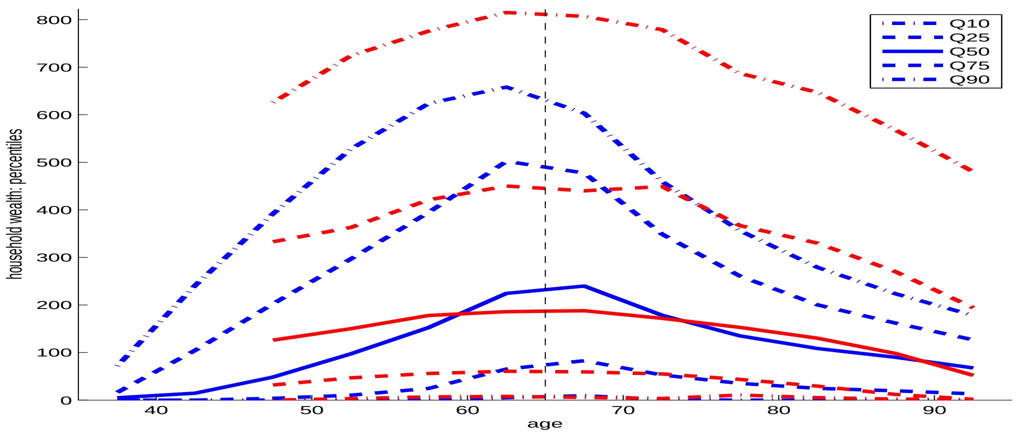
Calibration target	Data	Model
Median wealth (ages 70-75)	$178,600	$178,600
Informal care	44.7%	44.7%
Total PP/MA spending	0.821	0.821
Parent (healthy) gift	$1,548	$1,548
Kid gift to parent (PP)	$620	$620
Exchange transfer	$9,878	$9,878
Parameter	**Description**	**Value**
ρ	Discount rate	0.1280
C_f	Formal-care consumption penalty	$4,050
C_{ma}	Medicaid consumption floor	$4,650
α^p	Parent altruism	0.4781
α^k	Kid altruism	2.7×10^{-4}
ω	Kid bargaining weight	0.050

Parameters calibrated using model. Data source: HRS waves 2000-2010. Median wealth is of coupled and widow(er)/single households (excluding top 5%). Informal care is fraction of disabled widow(er)/singles receiving IC. Total private pay (PP) to Medicaid (MA) spending on nursing homes based on HCFA Office of the Actuary, National Health Expenditures, from Giacalone (2001). Parent mean gift is average annual gift from healthy parent(s) aged 65+ to all non-co-residing children. Kid mean gift is average gift to private-payer nursing-home parent. Exchange transfer is based on value of rent-free living and home-transfer to children in single-parent families with heavy-helper children. All transfers are averages and include zeros.

Savings behavior. We start with a comparison between the wealth distribution from the model and the one from our data in Figure 2. The model matches lower wealth quintiles very well, but does not create enough wealthy households. This is especially the case among the very old, so in this sense we have the retirement savings puzzle. The reason for low wealth of the very old in our model is that medical-expenditure shocks in old age, once netting out nursing-home expenses, are not that large any more; Medicare provides reasonable insurance against these shocks to the elderly in the US.[47] As pointed out before, nursing-home expenditures are

[47]For an overview of out-of-pocket medical expenditure see Table 12 in the Appendix.

Figure 2: Wealth quantiles by age



Data source: HRS waves 2000-2010. Household wealth ($000). Wealth distribution by age in model (blue) compared to data (red).

discretionary in our model, in contrast to much of the previous literature. The family provides additional insurance, making self-insurance through savings less urgent. However, wealth may also be low at high age in our calibration due to the shortcoming that the certain age of death is low in our calibration (due to the modeling constraints we face in our strategic setting).

Determinants of care arrangements. In order for our model to serve as a useful tool for evaluating policy, it is important that it fits well which families opt for which care arrangement. We now consider how the model performs quantitatively in matching the observed care arrangements by kids' education, parents' pension income, and parental wealth.[48] The first part of Table 5 shows that the model does a decent job in replicating the gradient between the two largest categories, *high school* and *some college*. However, the model counterfactually predicts no IC at all when all children in the family have a college degree. The model probably fails here for two main reasons: (i) education is an imperfect proxy for opportunity costs, and (ii) there is heterogeneity in altruism, which we ignore in our model.

The second part of Table 5 shows IC prevalence, split up by quintiles of the parent's SS benefits. The model predicts an arch, while the data suggests a slight downward trajectory when moving to higher pension quintiles. Specifically, our model suggests less IC in families with pension-poor parents than we observe in the data.

Finally, we turn to conditional correlations. We run a linear probability model on model-generated data, regressing the IC dummy on a polynomial in age and dummies for parental

[48]Kid's productivity in the model is mapped to education as described in Footnote 42 for parents.

Table 5: Informal care by economic characteristics

IC by kid education			
Source	high school	some college	college
Data	57.9%	47.0%	26.7%
Model	60.6%	45.9 %	0.0%

Data source: HRS waves 2000-2010. Education pertains to average education of children in a family with a widow(er)/single parent and heavy-helper children. Categories correspond to average education of at most 13 years of schooling, between 13 and 16 years of schooling, and 16 years and more.

IC by parent pension quintile					
Source	Q1	Q2	Q3	Q4	Q5
Data	47.0%	49.5%	48.2%	43.6%	40.7%
Model	21.1%	43.9%	62.2%	59.1%	46.2%

Data source: HRS waves 2000-2010. Pension quintiles (social security retirement, spouse or widow benefits) of disabled widow(er)s/singles.

Linear probability model for IC									
Source	low wlth	med wlth	high wlth	Q2	Q3	Q4	Q5	some collg	collg
Data	0.103	0.122	0.069	0.031	0.051	0.032	0.042	-0.081	-0.217
Model	0.621	0.624	0.626	0.213	0.245	0.209	0.128	-0.271	-0.877

Data source: HRS waves 2000-2010. Linear probability model of informal care for disabled widow(er)/singles. Low wealth is <90K, medium wealth is [90K,270K], and high wealth is >270K. Regression uses pension quintiles (social security retirement, spouse or widow benefits). Omitted variables: no wealth, pension quintile Q1, and average schooling of at most 13 years. Model estimates based on linear probability model using model-generated data.

wealth, public-pension quintiles, and kid education. We compare the results to those obtained from a regression very similar to the one presented in Section 2.[49] The quantitative predictions of the model are starker than those implied by the data. This is to be expected, since the regression covariates cover almost all determinants of IC in the model. In the data, however, there are omitted sources of heterogeneity (such as altruism, the income share of the marginal caregiver, etc.) and measurement error (especially in the kid's opportunity cost and parent wealth), both of which make us expect that the coefficients on economic variables are attenuated downward. The direction of the model's implications are, however, very much consistent with the data. In terms of parent's wealth, we see that the model successfully replicates the "threshold effect" we find in the data: When going from zero to the lowest wealth category, IC becomes more likely, but the likelihood of IC remains almost unchanged at higher wealth levels. In the data, there is only a weak relationship between parent's pension income and the probability of IC. In the model this relationship is also the weakest; it is hump-shaped whereas in the data it is more noisy. In both the model and the data, families with higher-educated children are less likely to

[49]The only difference here is that we now include only public pension income (as in the model), whereas, before we included all sources of income, and that we use quintiles of pension income instead of the logarithm of income.

rely on IC, ceteris paribus, the coefficient on the college category being by far the largest.

Transfer arrangements, nursing-home coverage, and gifts. Table 6 shows that in terms of non-targeted transfer arrangements, the model achieves a decent fit, but falls short in some dimensions. The model is very successful in generating bequest-motivated care in line with the data. The parent's high bargaining weight keeps contemporaneous transfers down. However, children in the model still provide care, since they can increase the expected bequest by protecting the wealth of the parent. The parent does not spend down her wealth recklessly due to the strong bequest motive implied by altruism, strengthening the bequest channel.

MA care in the model lies in the middle between the fraction of those who are fully-covered by MA and those who receive at least partial coverage. The fit is reasonable given that the model is constrained to pure forms of coverage.

The model overstates the mean of PP nursing-home expenditure when compared to purely-private payers in our HRS data. However, the number from the HRS, 40,355$, appears to be quite small in contrast to a Medicaid reimbursement rate of $38,500, which suggests that there is some measurement error in the error in the HRS data. The literature also hints at this possibility: Stewart et al. (2009), for example, report an average annual private nursing home price in the year 2000 of $45,800, based on the National Nursing Home Survey, which is very close to the number predicted by our model. In our model, average PP expenditure exceed the MA reimbursement rate by about 25%, which is in line with what has been documented in the literature (e.g. Norton, 2000).

The last three moments in Table 6 concern intra-family transfers. The model understates the number of kids who help out with their parent's nursing home (the extensive margin of gifts), which means that it overshoots on the intensive margin (recall that the unconditional mean was targeted). For the other targeted moment, gifts by healthy parents, however, the model is almost spot-on in the decomposition between extensive and intensive margin. Finally, in line with the data, the model generates very low transfers from kids to healthy parents. This is because kids' altruism is weak and the wealth distribution at this life stage is usually tilted in favor of parents.

Nursing-home entry and expenditures. We now have a closer look at nursing-home expenditures of private payers. Table 7 gives a comparison between the distribution for OOP nursing home costs generated by the model and our data, taking PP and MA individuals together. We pool both types since in the data there are many mixed forms of financing. Consistent with the data, median OOP expenditures are zero since so many elderly rely on MA. For individuals above the median, costs in the model increase more rapidly than in the data, but overall the model's predictions line up well with the data counterpart.

Table 6: Non-targeted moments

Description	Data	Model
Transfer arrangements:		
contemporaneous exchange	62.3%	79.2%
potential bequest	25.3%	20.8%
no measurable compensation	12.6%	0.0%
Nursing-home coverage:		
MA	41.9%	60.6%
mostly covered	14.3%	-
partially covered	16.0%	-
PP	27.8%	39.4%
Expenditure: PP	$40,355	$48,000
Gifts:		
parent (healthy) gives gift	15.0%	14.3%
kid gives gift (PP parent)	7.6%	3.9%
kid's gift to (healthy) parent	$85	$0

Statistics not targeted. Data source: HRS waves 2000-2010. Transfer arrangements are documented in Section 2.6. Nursing-home coverage is for widow(er)/single individuals with nursing home stay of at least 100 days to exclude Medicare cases. MA: fraction of elderly in nursing home with MA coverage and no expenditures. PP: fraction without coverage. Expenditure: PP: annualized average expenditure by private payers; for details on expenditures see Table 9 in the Online Appendix. *parent (healthy) gives gift*, fraction of healthy parent households giving positive gift amounts to children. *kid gives gift*, fraction of children giving positive gift amounts to parents in nursing home. *kid's gift* is average financial transfer from kids to non-disabled parents including zeros.

The second part of Table 7 shows the mean of nursing-home expenditures by pension quintile, again for all nursing-home residents. The model replicates the gradient present in the data, but overstates it somewhat. In the data, some low-pension individuals still face PP costs, whereas these individuals are all covered by MA in the model.

Finally, we ask how our model does in terms of the probability that a person ever enters a nursing home in her life. The last part of Table 7 shows nursing-home entry risk from the perspective of a healthy 65-year old individual by pension quintile in our model.[50] We see that individuals at the lower end of the productivity distribution have the highest likelihood to enter a nursing home, since they are the most likely to run down their wealth and qualify for Medicaid. The probability then decreases, but ticks up again for the highest quintiles. The reason for this is two-fold. First, high-productivity parents tend to have high-opportunity cost children. Second, high-productivity parents tend to be richer, and IC is an inferior good in our model.

[50] We could not find estimates for nursing-home entry risk by education or pension category. For the entire population, the model prediction (33.4%) is somewhat lower than estimates of others in the literature. For example, Brown & Finkelstein (2008) estimate a probability of 39 percent at age 65 of ever being admitted to a nursing home prior to death. This is likely due to the fact that the model's life cycle ends at age 95.

Table 7: Nursing-home statistics

Nursing-home expenditures					
Source	50pct	75pct	90pct	95pct	99pct
Data	0K	17K	42K	60K	109K
Model	0K	43K	53K	60K	73K
Mean expenditures by pension quintile					
Source	Q1	Q2	Q3	Q4	Q5
Data	9K	9K	14K	16K	20K
Model	0K	1K	4K	16K	40K

Data source: HRS waves 2000-2010. Percentiles of annual nursing-home expenditures and mean expenditures by pension quintiles. Includes all widow(er)/single nursing home residents living at least 100+ days in nursing home. In model, nursing home expenditure is zero for Medicaid recipients and equals cost of basic care plus private consumption for private payers.

Nursing-home risk (model, age 65)

Pension quintiles	Q1	Q2	Q3	Q4	Q5	Total
Probability	46.6%	35.6%	24.2%	25.4%	33.8%	33.4%

Probability of ever entering PP or MA at age 65 by pension quintiles.

5 Policy experiments

We now study counterfactual experiments in order to evaluate policy proposals that have been discussed in the political arena. We always present the long-run effects on allocations, i.e. we use the ergodic distribution over families. For welfare, we show both short- and long-run results.

5.1 Policy experiments I: Germany

Our first set of counterfactuals is based on the German LTC program, introduced in 1995. It makes subsidies available for either informal or formal care. For individuals that we classify as *disabled*, the current (as of 2015) home-care subsidy, is \$4,375 per year; for individuals living in a nursing home it is \$11,460 per year (always expressed in year-2000 dollars).[51] We assume that the IC subsidy is paid to both caregiving kids and parents who give care to husbands

[51] Our information is from the *Tabelle Pflegeleistungen BRat* by the German Ministry of Health as of 2015. Subsidy amounts depend on care needs, which are classified into I, II, III, with sub-categories according to dementia. Most relevant to us are levels II and III, which correspond to daily care of at least 3 hours. For s_{pp}, we draw on the subsidies for institutional care: We take the subsidy for level III (1,612 Euros per month), which lies just between the levels for II and III-*Härtefall*. For s_{ic}, we draw on the subsidies for care at home: We first average the subsidies within II (458 Euros, but 545 with dementia) and then average again with III (728). We then convert to USD in PPP, use the CPI to deflate to 2000, and convert to yearly amounts.

(i.e. a *caregiver allowance*). We provide separate results for an IC subsidy that is restricted to working-age individuals (i.e. kids only).

Table 8 provides an overview of the equilibrium effects of the LTC policy options we consider. In the experiment $s_{ic} \uparrow$, an annual subsidy of \$4,375 is given to informal caregivers of any age. The subsidy strongly reduces MA in favor of IC, also –to a lesser extent– crowding out PP care. More IC care is provided without contemporaneous compensation from the parent due to the caregiver allowance. The type of IC that grows most is care that is not accompanied by a contemporaneous transfer; kids are willing to do this due to the caregiver allowance.

We decompose the tax change required to finance the subsidy $\Delta\tau$ into three contributions: (i) $\Delta\tau_s$: the change due to the payout of the subsidy itself, (ii) $\Delta\tau_{ma}$: the change due to changes in the size of the MA program, and (iii) $\Delta\tau_{inc}$: changes to income-tax revenue, which are chiefly caused by changing labor supply of caregivers.[52] The payout of the IC subsidy increases the tax rate by one-quarter of a percentage point. However, this is offset to a large extent by crowding-out of the comparatively expensive MA program. An additional cost of this subsidy is that it shrinks the labor force. But the resulting loss in tax revenue is fairly small, since IC is taken up by children of low productivity. We observe the most dramatic increase of IC among parents with low SS benefits because it allows them to exit MA.

In terms of wealth, we see that savings at age 70-75 decrease, and more so at the lower end of the wealth distribution. This is because the subsidy diminishes the need for self-insurance as it renders family-provided care cheaper. Over the short run, the welfare gain for unborn agents under the veil of ignorance is large, but from a long-run perspective there is a slight welfare loss.[53] This is driven by the fact that savings decrease, such that future new-borns are born into families with poorer parents. Also, all young individuals face higher taxes (we show the welfare implications of current generations below).

It is interesting to compare this unconditional IC subsidy to one which is conditional on the caregiver being of working age. The row $s_{ic} \uparrow$ *(to young)* shows the effects of such a policy. The care arrangements change as before, since the payoffs of the marginal caregivers are affected in the same way and general-equilibrium effects are weak. But the direct cost of the subsidy is only about half that before, since about half of all informal caregivers are of retirement age,

[52] $\Delta\tau_{inc}$ is also affected by changes in savings behavior, but the labor-supply channel seems to dominate in our counterfactuals. Changes in the government budget stemming from payments for medical shocks are negligible; such payments account for only 0.1% of tax revenue our economy.

[53] We compute the short-run CEV as that of an individual born into an economy with taxes and subsidies as in the counterfactual, but being matched to an age-65 parent from the baseline wealth distribution. The long-run CEV is the same, but matching the kid to a parent from the ergodic wealth distribution under the counterfactual.

Table 8: Policy experiments

LTC policy	**Care type (%)** IC	MA	PP	**Costs (as $\Delta\tau$)** $\Delta\tau =$	$\Delta\tau_s +$	$\Delta\tau_{ma} +$	$\Delta\tau_{lbr}$	**Wealth** ($000, age 70-75) p25	p50	p75	**Ex-ante CEV** short run	long run
Status quo	44.7%	33.5%	21.8%					$53K	$178K	$349K		
$s_{ic} \uparrow$	59.0	23.6	17.4	0.11	0.25	-0.20	0.06	44	163	333	**0.380**	**-0.033**
$s_{ic} \uparrow$ (to young)	59.0	23.6	17.4	-0.01	0.13	-0.20	0.06	45	165	335	0.323	0.012
$s_{pp} \uparrow$	23.6	32.1	44.3	0.22	0.32	-0.03	-0.07	48	164	320	-0.098	-0.275
$s_{ic} \uparrow + s_{pp} \uparrow$	44.0	22.9	33.1	0.25	0.47	-0.21	-0.01	40	152	311	**0.352**	**-0.193**
MA↑	40.3	40.2	19.5	0.20		0.21	-0.01	37	163	340	0.111	-0.361
MA↓	50.1	25.5	24.4	-0.22		-0.20	-0.02	78	198	361	-0.360	0.288
MA↓ + $s_{ic} \uparrow$	62.8	18.1	19.2	-0.03	0.26	-0.34	0.05	61	176	337	**0.221**	**0.300**

Policies: $s_{ic} \uparrow$: informal-care subsidy of $4,375 (per year). $s_{pp} \uparrow$: private-payer subsidy of $11,460 (per year). $MA \uparrow$: 20% increase to both y_{ma} and C_{ma}. $MA \downarrow$:20% reduction in both y_{ma} and C_{ma}. $s_{ic} \uparrow + s_{pp} \uparrow$: both informal- and formal-care subsidy, amounts as in $s_{ic} \uparrow$ and $s_{pp} \uparrow$. $MA \downarrow + s_{ic} \uparrow$: combination of $MA \downarrow$ and $s_{ic} \uparrow$. **Care arrangements**: IC: informal-care prevalence, MA: Medicaid prevalence, and PP: private-payer prevalence. **Costs**: $\Delta\tau$: change to the income tax rate required to finance LTC policy. Changes to tax rate due to: payout of subsidy $\Delta\tau_s$, changes in MA ($\Delta\tau_{ma}$), and change to income taxes ($\Delta\tau_{inc}$). Changes to government spending on medical shocks are negligible. **Wealth**: quantiles of wealth distribution ages 70-75. **CEV**: consumption equivalent of new-born under veil of ignorance. Short run: at time of reform (facing new tax rate, weighting with baseline measure over families), long run: after convergence (weighting with ergodic measure from counterfactual).

LTC policy	**IC transfers** Exchg	Beqst	Altrsm	**FC Financing** $g^k > 0$	$g^k = 0$	MA	**IC by kid educ** HS	HS+	Collg	**IC by parent pension** Q1	Q2	Q3	Q4	Q5
Status quo	79.2%	20.8%	0.0%	1.5%	37.9%	60.6%	60.6%	45.9%	0.0%	21.1%	43.9%	62.2%	59.1%	46.2%
$s_{ic} \uparrow$	72.5	27.1	0.4	2.3	40.2	57.5	79.9	59.8	0.1	49.0	57.6	70.7	67.0	54.3
$s_{ic} \uparrow$ (to young)	72.4	27.2	0.4	2.3	40.3	57.4	80.1	59.7	0.1	49.3	57.7	70.5	66.9	54.2
$s_{pp} \uparrow$	91.9	8.1	0.0	2.4	55.5	42.1	49.1	0.01	0.0	15.3	28.4	32.9	27.2	17.9
$s_{ic} \uparrow + s_{pp} \uparrow$	86.9	12.4	0.7	3.6	55.6	40.9	77.2	19.8	0.0	46.0	48.5	51.4	43.3	30.7
MA↑	80.9	19.1	0.1	0.5	32.1	67.4	54.0	42.2	0.0	16.7	34.2	55.9	57.4	46.1
MA↓	75.8	24.2	0.0	3.1	45.8	51.1	68.8	50.3	0.0	30.0	55.9	66.6	59.8	46.3
MA↓ + $s_{ic} \uparrow$	68.0	31.4	0.6	5.1	46.4	48.5	83.5	65.5	0.1	53.2	67.2	74.4	67.7	54.3

IC Transfer: *Exchg*: IC with $g^k > 0$. *Beqst*: IC with $g^k = 0$, $a^p > 0$. *Altrsm*: IC with $g^k = a^p = 0$. **FC Financing**: PP care with $g^k > 0$, PP care with $g^k = 0$, MA care. **IC by kid educ**: IC among education groups; HS is high school; HS+ is more than high school and less than college. **IC by parent pension**: IC by parent pension quintile.

and the policy turns out to be budget-neutral. The short-run gain in welfare remains sizeable, while over the long run the loss turns into a small gain, driven by the fact that the tax rate is practically unchanged.

In the third experiment, $s_{pp} \uparrow$, an annual subsidy of \$11,460 is given to all PP of nursing homes (without a means test).[54] Support by the subsidy is relatively generous, covering almost one-fourth of average PP expenditures in the model (\$48,000), or more than half of basic care services (\$21,600). The subsidy almost doubles the prevalence of PP care, the increase being driven almost exclusively by a reduction in IC. This is a stark example of what we may miss when ignoring the family margin. The outflow from IC (21.1 percentage points) is about 15 times that from MA (1.4 p.p.). We find that the decrease in IC occurs especially in families with medium opportunity costs, allowing many informal caregivers to stay in the workforce and giving rise to additional tax revenue.

However, the PP subsidy leaves the MA population almost unchanged since for them paying privately for a nursing home is still too expensive. Thus, there are almost no cost savings except for a modest decrease in the tax rate due to the additional labor supply. Overall, this subsidy is much more expensive than the IC subsidy. Savings are reduced, especially in richer families. Lower parent wealth together with the higher tax rates means that children entering the economy in the long run suffer large welfare losses.

In the fourth type of policy, we combine the IC subsidy, $s_{ic} \uparrow$, and the PP subsidy, $s_{pp} \uparrow$. This experiment mimics the mix of subsidies currently available in Germany. Our model predicts that in the US such a policy would leave IC almost unchanged due to two offsetting effects. On the one hand, more low-productivity kids provide IC due to the caregiver allowance. On the other hand, the PP subsidy allows the elderly to shift from IC to PP and thus especially higher-productivity children are able to return to market work. The two effects are offsetting, leaving income-tax revenues almost unaffected. This mix of subsidies decreases wealth by more than any of the other policies. Thus, this policy allows for increased current consumption and therefore is popular in the short run. In the long run, however, it is disliked since savings decrease and the tax rate increases.

Before moving on to study changes to the size of MA, we consider how welfare of currently alive generations is affected by two selected German-style policies. Table 9 provides consumption equivalent variations (CEVs) for children and parents, dividing the population by age and productivity groups of kids and parents. We average CEVs for each group, weighting by the

[54] This subsidy is also paid to the measure $s_m(1 - \iota)$ of males in a PP nursing home in parent households with $s = 0$.

Table 9: German-style policy: welfare of currently alive generations

	$s_{ic}\uparrow$				$s_{ic}\uparrow$+$s_{pp}\uparrow$			
	children		*parents*		*children*		*parents*	
group	average	% +	average	% +	average	% +	average	% +
all	+0.940	99.1%	+3.479	99.9%	+1.093	90.2%	+5.907	99.9%
parent below 80	+0.582	98.2%	+3.056	100.0%	+0.528	80.5%	+4.962	100.0%
parent above 80	+1.336	100.0%	+4.686	99.7%	+1.668	99.8%	+8.604	99.5%
low-prod kid	+1.084	97.7%	+4.127	100.0%	+1.182	93.3%	+4.179	100.0%
high-prod kid	+0.761	100.0%	+2.874	100.0%	+0.962	82.8%	+8.678	100.0%
low-prod parent	+0.814	96.5%	+4.055	99.8%	+0.934	90.5%	+4.514	99.9%
high-prod parent	+0.731	100.0%	+2.779	100.0%	+0.627	74.6%	+7.341	99.9%

Consumption equivalent variations of current children and parents by age and productivity groups. Average is taken over CEVs and % + means fraction out of the group which has a positive CEV.

density of households in the baseline model, and report how many agents in the group have a positive CEV (% +). In the status quo, before changes to wealth have taken place, individuals across the board benefit from both the IC and the combined subsidy. CEVs are positive for practically all individuals. Maybe unsurprisingly, parents are in favor of policies from which they benefit but that they do not have to pay for. For kids, the additional insurance and the fairly small increase in the tax rate allows to increase consumption. Furthermore, undesirable MA is crowded-out, which particularly benefits the elderly above age 80 and allows them to stay home or make use of a more desirable private-payer nursing home. Low productivity children benefit more than high productivity ones as they are especially affected by the policy. When only the IC subsidy is available, low-productivity parents (and low-productivity kids) gain more than high-productivity ones since they are the ones who can stay out of MA. When offering both subsidies, high-productivity parents (and high-productivity kids) gain a lot since they make up much of the private-payer population.

5.2 Policy experiments II: Changes to Medicaid

Next, we ask the question what the effects of an expansion (or shrinking) of the Medicaid program would be. In reality, such an expansion would be implemented by making eligibility criteria less stringent. In our model, MA uptake is a choice. We thus model the MA expansion as an increase to the consumption floor. We study quantitative changes that are on the order of the variation in MA reimbursement rates that we currently see between US states.

Consider first the counterfactual $MA \uparrow$, in which we study a 20% *increase* to C_{ma}. We assume that this increase in C_{ma} is matched by a 20% increase to y_{ma} (government expenditures on non-care consumption per MA recipient), which amounts to an 8.3% (or 3,088$) increase in the Medicaid reimbursement rate.[55] As Table 8 shows, the policy reduces both IC and PP by about 10%. MA finances now two-thirds of all formal care. This policy is relatively expensive. The additional labor supply leaves the government budget practically unchanged because only families with low-productivity children respond. There are fewer PP of nursing homes and so additional costs are shifted to the public sector. The need for self-insurance at the low end of the wealth distribution becomes much less pressing, thus savings decrease. In the long-run, this is the least popular policy option among all we consider, and it only leads to a modest increase in welfare in the short run.

Second, consider the reverse scenario, $MA \downarrow$, in which we decrease both C_{ma} and y_{ma} by 20%. Both IC and PP increase. The existence of the family as an informal-insurance network buffers the loss in public insurance. Bequest-motivated care increases and children provide additional financial support to PP parents. Furthermore, cost savings are fairly substantial and so the tax rate decreases. As a result of the additional savings and the lower tax rate there is actually a substantial welfare gain from a cut in Medicaid in the long run. But the policy is the least popular in the short run, driven by the large losses of the oldest and poorest parents.

The popularity of a cut to MA in the long run and the large short-run gains from IC subsidies beg the question if a combination of the two policies could create gains on all fronts. The last row of Table 8, which shows the effects of a policy of combining a cut to the size of MA with a simultaneous introduction of the IC subsidy, tells us that this is indeed the case. This combined policy increases IC substantially, especially among low-income households. MA is crowded out a lot more than in scenario $MA \downarrow$, and the fraction of PP only decreases slightly. The policy is budget-neutral since the savings on MA pay for the subsidy. Still, wealth-poor individuals increase savings to self-insure, since the IC subsidy does not induce the moral hazard for savings that the MA consumption floor creates. For the top 50% of the wealth distribution precautionary savings are almost unchanged since they were using MA less in the first place.

Table 10 shows the welfare effects to currently-alive generations of reducing the size of MA with and without an IC subsidy. In scenario $MA \downarrow$, there are welfare losses across the

[55] Cutler & Sheiner (1994) report the standard deviation of MA reimbursement rates to be about 10% of average nursing-home costs. Thus the change we consider in the counterfactual is roughly on the order of between-state variation in MA reimbursement rates in the US .

Table 10: Changes to Medicaid: welfare of currently alive generations

	$MA\downarrow$				$MA\downarrow$+$s_{ic}\uparrow$			
	children		*parents*		*children*		*parents*	
group	average	% + for	average	% + for	average	% + for	average	% + for
all	-0.889	3.5%	-3.907	6.4%	+0.374	82.3%	+0.451	75.3%
below 80	-0.415	7.1%	-3.269	6.5%	+0.367	91.5%	+0.571	77.0%
above 80	-1.175	0.0%	-5.728	6.2%	+0.566	88.7%	+0.109	70.7%
low-prod kid	-1.360	5.1%	-4.779	0.0%	+0.235	66.3%	+0.583	74.0%
high-prod kid	-0.415	1.5%	-2.864	15.3%	+0.484	94.3%	+0.736	78.1%
low-prod parent	-0.784	8.0%	-6.896	0.1%	+0.377	85.0%	-1.669	49.5%
high-prod parent	-0.478	1.0%	-1.240	14.7%	+0.387	92.0%	+2.340	97.6%

Consumption equivalent variations of current children and parents by age and productivity groups. Average is taken over CEVs and % + for means fraction of generation which has a positive CEV.

board. Low-productivity families and the oldest are especially hard-hit. Informal care does not respond strongly enough to enable poor elderly to receive IC since these individuals have little to offer in exchange for care. Consumption drops as agents now feel a larger need to self-insure (which is why wealth increases). The decrease in the payroll tax is insufficient to make up for the losses.

Matters look much better when additionally introducing the IC subsidy. Since IC responds substantially the welfare losses to most parents are undone. Low-productivity parents still experience a large loss in welfare albeit much smaller than without the subsidy. Parents with low-productivity children now also experience a welfare gain since they obtain IC instead of Medicaid-financed care. High-productivity parents gain a lot, as more of them receive IC (which they prefer over nursing-home care), and they pay slightly lower taxes. Children typically gain from this policy. The IC subsidy will also be available to them and they have enough time to engage in precautionary savings.

5.3 IC elasticities vis-a-vis the empirical literature

Our model predicts fairly large behavioral responses of single disabled individuals to changes in relative prices of care. A back-of-the-envelope calculation tells us that per 1,000$-increase in the IC subsidy, there is a reduction of 5.9% in formal care.[56] The PP subsidy leads to a 3.3%

[56]Formal care (FC=MA+PP) is 55.3% in the baseline calibration, being reduced to 41.0% in $s_{ic}\uparrow$, a 25.9% change. We divide this number by the subsidy amount, 4,375$, to obtain the elasticity, 5.9%.

increase in formal care per 1,000$. How large are these responses compared to what we know from empirical work? Unfortunately, there are no estimates for the US for IC or PP subsidies, simply because such policies have never been tried in the US.

However, there is a number of studies that exploit variation in the generosity of the MA program, both across time and across US states. The estimates by Cutler & Sheiner (1994), who exploit cross-state variation, imply that a decrease in the MA reimbursement rate of 10% of the average nursing-home cost leads to 11% lower nursing-home use.[57] This is close to our counterfactual $MA \downarrow$, where a reduction of MA reimbursement rates by 8.3% ($\Delta y_{ma}/(y_{ma} + p_{bc})$) leads to a 10% decline of formal care. Hoerger et al. (1996) find that lowering MA reimbursement by 10,000$ per patient (in a lifetime) reduces nursing-home entry by about 15%. This again lines up quite well with our model prediction, when considering that disabled individuals typically stay in nursing homes for several years. Garber & MaCurdy (1993) find that nursing-home use is quite price-sensitive, studying the nursing-home discharge hazard at 20 days (when co-payments increase) and at 100 days (at which point Medicare stops paying). However, other studies fail to find significant effects of MA rules on nursing-home use, such as Grabowski & Gruber (2007), who exploit time variation in state MA rules; Norton & Kumar (2000), exploiting time variation in spousal impoverishment rules; and Reschovsky (1996), who finds no effect of MA income and asset tests on nursing-home entry. We conclude that the elasticity of care choices from our counterfactuals $MA \uparrow$ and $MA \downarrow$ are at the upper end of the empirical estimates.

Goda et al. (2011) provide an estimate for the income elasticity of care choices that we can compare to our model. They use the "social-security benefits notch"[58] to estimate the causal effect of income on care choices. They find that an exogenous increase in yearly (permanent) social-security income of 1,000$ (in 1993$) cuts nursing-home use of low-education Americans by one-third, informal care rising by about the same magnitude. In our model, we find that a 1000$ (in year-2000 dollars) increase in a widow's SS benefits is associated with a 21% decrease in formal-care usage among the lowest income groups, ceteris paribus.[59] Thus our

[57] To be precise, they estimate that decreasing the MA reimbursement rate by 4,60$ (which amounts to 10% of the average nursing-home cost they report) entails a drop in the nursing-home utilization rate of 1.7 percentage points (relative to a mean of 15%).

[58] ...the fact that birth cohorts around 1915 received permanently higher social-security benefits than comparable workers born before and after due to legislation errors in the 1970s

[59] Goda et al. (2011) exclude all individuals with high school and more in their estimation. Our number (-21%) is calculated using the linear probability model estimated on model-generated data reported in Table 5. One could also compare their number to the *unconditional* gradient in our model, which is only about half as large, at 10% per 1,000$ (we obtain this by comparing formal-care prevalence between the two lowest grid points of parent productivity, which we identify with lower-than-high-school individuals in the data).

income elasticity is somewhat lower than the empirical one.[60]

5.4 Discussion

Are our welfare results robust to features of reality that our model omits? One concern is that in families with multiple children, children may interact strategically in the care decision.[61] In our setting, the kid generation makes up one decision unit. We thus implicitly assume that all children in the family share the marginal caregiver's opportunity costs of care. This resource pooling among siblings implies transfers among siblings, but we do not have information on such transfers in our data. However, the fact that parents favor caregiving children over their siblings when giving inter-vivos transfers and bequests shows that indeed substantial shifting of economic resources from non-caregiving to caregiving children takes place within the family. Thus we see our modeling strategy as a useful first approximation and leave more careful study of this issue for future research.

Another potential omission of the model is that informal caregivers may lose human capital in addition to the contemporaneous opportunity costs of caregiving that we consider in our model. But this omission is probably not as large of a concern as one may first think. Heavy-helping caregivers are 48 years on average, and thus close to the end of their careers, and are also typically of low education (only 18% have a college degree).[62] An arguably bigger concern is that a caregiver gives up the match quality of her job (i.e. she may lose a position that fits her skills well and that is hard to recover after a prolonged absence). A short-cut to address these issues in our model is to increase the opportunity cost from caregiving by lowering the gender-earnings gap, which is encoded in the parameter β. This means that the marginal caregiver contributes a larger fraction to household income. This scenario is also of interest per se in view of two trends: rising higher female labor-market participation rate and the narrowing of the gender-earnings gap.

We consider a scenario where we lower β from 0.66 to 0.57. This amounts to a two-third reduction of the gender-earnings gap.[63] We maintain all other parameters as in the baseline calibration. We find that IC is lowered by about 10 percentage points (down to 33.7%) with respect to our baseline calibration. Of this 10 percentage-point decrease, three percentage points

[60] The difference would be larger when considering that there is also a number of formal-care-receiving married individuals in our model who behave inelastically by assumption.

[61] For literature on "gaming" among siblings, we refer the reader to Sovinsky & Stern (2014) and the references therein.

[62] For caregiver statistics, see Table 4 in the Online Appendix.

[63] We define the gender-earnings gap as $\beta/(1-\beta)-1$, thus it decreases from 100% (baseline) to 33% ($\beta\downarrow$).

take up MA (up to 36.7%) and the rest make use of PP (up to 29.6%). The tax rate increases just slightly (by 0.03 percentage points). Higher use of MA contributes a 0.06-percentage-point increase, but higher labor supply contributes a 0.03-percentage-points decrease. Table 13 in Appendix C presents the results of the various policy experiments in this alternative world. By and large, the results are qualitatively the same as in the baseline. The behavioral changes are muted, and the welfare effects are somewhat smaller.

There are also other trends that will make the situation for the government more challenging than our model has it: an increasing dependency ratio (parents-to-kids), rising divorce rates, and fast-rising nursing-home prices. A rigorous treatment of these trends would be very interesting, but is beyond the scope of the current paper. We leave it for future research.

6 Conclusions

In this paper, we have presented a model of LTC provision in which family members dynamically interact without commitment. The model suggests that a German-style informal-care subsidy generates welfare gains in the short run and is especially beneficial for low-income individuals. When combined with a reduction of the Medicaid program, the informal-care subsidy is welfare-enhancing for a large majority of the population in both the short and the long run.

We conclude by briefly discussing practical effects of the subsidies considered that go beyond our framework.

In reality, implementing a non-means-tested formal-care subsidy may pose a challenge: policy makers have to make the case why financial support should be given even to those who need it least, e.g. wealthy individuals who can easily afford to pay for a private nursing home. Another concern with a formal-care subsidy may be that it enables nursing homes to appropriate some of the consumer surplus and charge higher prices (that problem, however, may be already present with Medicaid). But, an increase in nursing-home demand from private agents may plausibly lead to more competition among formal-care providers. This would help to control the price of care, giving a rationale for supporting such a subsidy.

An informal-care subsidy to family caregivers, as has been introduced in Germany, is an attractive policy option. However, an informal-care subsidy requires a disability certification scheme in order to deter families from untruthfully claiming disability. Such a certification scheme has its costs, but it may also offer unexpected benefits. It makes it easier for agents to write Arrow-Debreu-style contracts that pay benefits contingent on disability status and not on nursing-home residency, thus keeping open a larger range of options to the individual. Such contracts are indeed already available on the German market.

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A Theory appendix

In all of the following, $\lambda(z)$ denotes the stationary measure of families over the state space. Kids with dead parents are included in this measure, making the obvious adjustments.

A.1 Government: Taxation and budget constraint

Using the stationary measure of families $\lambda(z)$ over the state space, the government's budget constraint is then:

$$
\begin{aligned}
&\underbrace{\int \big[T^p(z) + T^k(z, h(z)) + \nu T^k(z, 0)\big]\mathrm{d}\lambda(z)}_{\text{tax revenue}} \\
&= \underbrace{\int s\Big(h(z)s_{ic} + (1 - h(z))\big[(1 - m(z))s_{pp} + m(z)(p_{bc} + y_{ma})\big]\Big)\mathrm{d}\lambda(z)}_{\text{LTC spending on widows}} \\
&\quad + \underbrace{\int (1 - s)s_m(z)[\iota s_{ic} + (1 - \iota)s_{pp}]\mathrm{d}\lambda(z)}_{\text{LTC spending on husbands}} + \underbrace{\int y_p(\epsilon^p)n^p(j^p, \epsilon^p, s)\mathrm{d}\lambda(z)}_{\text{SS benefits}} \\
&\quad + \underbrace{\int \int \big[\max\{M - a^p, 0\}\mathrm{d}F_m(M)\big]\delta_m(z)\mathrm{d}\lambda(z)}_{\text{means-tested benefits covering medical expenditures}} + \underbrace{G}_{\text{other expenditures}}
\end{aligned}
\tag{18}
$$

Tax revenues consist of the sum over parent's and kid's tax payments, weighted by the stationary measure λ over families. Note that the ν infra-marginal kid households households never give informal care, but for the marginal kid household the IC decisions $h(z)$ matters. Government spending consists of the following items: (i) LTC subsidies and Medicaid spending for widows in households with $s = 1$, which depends on the IC and MA decisions, h and m, (ii) LTC subsidies to disabled husbands in households with $s = 0$, (iii) spending for households that do not have enough wealth to pay for medical shocks M, and (iv) other government expenditures, G, including social-security benefit payments (since we do not consider changes to demography in the counterfactuals and the labor-productivity process is exogenous, SS benefit payments are constant across all scenarios).

A.2 Details on the HJBs and boundary conditions

The jump terms in the HJB, Equation (3), are

$$J^i(z) = \underbrace{\sum_{m=1}^{N^\epsilon} h^\epsilon(\epsilon^k, \epsilon_m) V^i(\cdot, \epsilon_m, \epsilon^p, j^k)}_{\text{kid's productivity risk}} + \underbrace{(1-s)\delta_s(z)\big[V^i(a^k, a^p, 1, \cdot) - V^i(z)\big]}_{\text{LTC risk}} \tag{19}$$
$$+ \underbrace{\delta_d(z)\big[(\alpha^p)^{\mathbb{I}\{i=p\}} Z(a^k + a^p, \epsilon^k, j^k) - V^i(z)\big]}_{\text{death risk}}$$
$$+ \underbrace{\delta_m(z) \int V^i(a^k, \max\{a^p - M, 0\}, \cdot) \mathrm{d}F_m(M)}_{\text{medical-spending shocks}},$$

where $Z(a^k, \epsilon^k, j^k)$ is the value for the kid generation when parents are dead and kids have the following state: wealth a^k, productivity ϵ^k, and age j^k. Z obeys the following HJB, which is standard for consumption-savings problems:

$$\rho Z(a^k, \epsilon^k, j^k) = Z_j(a^k, \epsilon^k, j^k) + \max_{c^k \geq 0} \Big\{ u^k(c^k) + \big[y(\epsilon^k, j^k) + r a^k - c^k\big] Z_a(a^k, \epsilon^k, j^k) \Big\} \tag{20}$$
$$+ \sum_{m=1}^{N^\epsilon} h^\epsilon(\epsilon^k, \epsilon_m) Z(a^k, \epsilon_m, j^k),$$

where subscripts to Z denote partial derivatives. At age j_{ret}, the kid generation splits up into $(1+\nu)$ new parent households and is matched to a new kid with the same productivity and zero wealth. This imposes the following boundary condition:

$$Z(a, \epsilon, j_{ret}) = (1+\nu) V^p\Big(0, \frac{a}{1+\nu}, 0, \epsilon, \epsilon, j_{ret}\Big) \qquad \forall a, \epsilon. \tag{21}$$

Finally, the fact that parents die with certainty at j_{dth} imposes the boundary conditions

$$V^i(a^p, a^k, s, \epsilon^k, \epsilon^p, j_{ret}) = (\alpha^p)^{\mathbb{I}\{i=p\}} Z(a^k + a^p, \epsilon^k, j_{ret}) \qquad \forall a^p, a^k, s, \epsilon^k, \epsilon^p, \qquad \text{for } i \in \{k, p\}. \tag{22}$$

A.3 Equilibrium Definition

A recursive equilibrium consists of value functions for the kid, V^k, the parent, V^p, kids with dead parents, W; policy rules for the kids, $\{g^k, c^k\}$, the parent, $\{g^p, m, c^p\}$, kids without parents, $\tilde{c}^k$, an informal-care rule, h, and an informal-care transfer function, Q^*; prices $\{w, p_{bc}\}$; a government policy, $\{s_{ic}, s_{pp}\}$; and a stationary measure $\lambda(z)$ over families such that:

1. Both kid and parent are best-responding to the other, i.e. the value functions V^k and V^p satisfy (3)- (12) taking as given the policy rules by the other player. Also, the maxima in (5)- (7) are attained by the policies c^k, c^p, m, g^p, g^k.

2. The value function W satisfies (20), the maximum being attained by $\tilde{c}^k$,

3. The value functions V^p, V^k, W jointly satisfy Equations (19)-(22),

4. The informal-care decision rule, h, and the transfer rule, Q^*, are the Nash-bargaining solution between kid and parent, i.e. they satisfy (10)- (12).

5. Firms maximize profits given prices, i.e. L_y and L_f attain the maximum in (13) and (14), respectively

6. Markets clear, i.e.

$$\int y(j^k, \epsilon^k)[1 + \nu - (1 - \beta)h(z)]\mathrm{d}\lambda(z) = L_y + L_f \quad \text{(labor)}$$

$$G + \int c^p + c^k + r(a^p + a^k) + my_{ma} + \delta_m(z) \int M \mathrm{d}F_m(M)\mathrm{d}\lambda(z) = A_y L_y \quad \text{(consumption good)}$$

$$\int s\big[1 - h(z)\big] + (1 - s)s_m(1 - \iota)\mathrm{d}\lambda(z) = A_f L_f \quad \text{(formal care)}$$

7. The government's budget is balanced, i.e. (18) holds.

8. λ is the ergodic density over families given the law of motion induced by optimal decision.

In the game between parents and kids, we restrict attention to the equilibrium that arises as the limit of a finite dynasty. A *finite dynasty* is one in which there exists a final parent generation that has no kids but faces otherwise the same physical environment as the other generations.

A.4 Solving the instantaneous game: Stages 2-4

We take as given the value functions $\{V^p, V^k\}$ and their derivatives and proceed by backward induction to characterize the equilibrium of the instantaneous game.

A.4.1 Consumption choice

Since $u^i_{cc}(\cdot) < 0$ for $i \in \{k, p\}$, the optimal consumption choice in the final stage of the game can be backed out from the first-order condition $u^i_c(c^i, \cdot) = V^i_{a^i}$ as in Barczyk & Kredler (2014*a*):

$$c^i(z, V_a; y_4, h, m) = \begin{cases} c^i_{unc} & \text{if } a^i > 0, \\ C_{ma} & \text{if } i = p \text{ and } m = 1, \\ \min\left\{c^i_{unc}, y_{i,4}\right\} & \text{otherwise.} \end{cases} \tag{23}$$

$$\text{where} \quad c^i_{unc} = \left(\frac{n^i(z)(1+\nu)^{\mathbb{I}\{i=k\}}}{\phi(n^i(z))^{1-\gamma} V^i_{a^i}}\right)^{\frac{1}{\gamma}} + \mathbb{I}\{i = p\} s(1-h) C_f$$

The parent is constrained to consume C_{ma} in case she is in MA. When having zero wealth, each agent may be constrained to consume their income-on-hand, $y_{i,4}$. Finally, note that when the parent is in PP, $s(1-h)(1-m) = 1$, then the parent needs C_f units of consumption more to obtain the same marginal utility as in IC.

A.4.2 Medicaid (MA) decision

We now go back to the parent's MA choice in Stage 3. We first note that the child will choose the same consumption level, c^k, in the final stage, no matter what the parent's MA choice is. We can easily see this to be true from (4) since the child's income-on-hand, $y_{k,4}$, is the same irrespective of the parent's MA decision. Taking together (6) and (5), a broke parent in formal care thus chooses MA for in Stage 3 if and only if

$$u^p(C_{ma}, h = 0; z) > \underbrace{u^p(c_{pp}, h = 0; z) + [y_{p,3} - p_{bc} + s_{pp} - c_{pp}]V^p_{a^p}}_{=G(y_{p,3})}, \tag{24}$$

$$\text{where} \qquad c_{pp} = c^p(z, V_a; [y_{k,3}, y_{p,3} - p_{bc} + s_{pp}], h = 0, m = 0).$$

Note that if the parent is constrained in PP, she chooses PP iff the consumption level she can afford in PP, $c_{pp} = y_{p,3} - p_{bc} + s_{pp}$, exceeds C_{ma}. In general, the function $G(\cdot)$ defined on the right-hand side of (24) is strictly increasing in $y_{p,3}$. We can thus implicitly define a threshold income level y^p_{thr} that characterizes the optimal MA choice as

$$m(z, V_a; y_3, h) = s(1-h)\mathbb{I}\{a^p = 0\}\mathbb{I}\{y_{p,3} < y^p_{thr}\}, \qquad \text{where } y^p_{thr} \text{ solves}$$
$$G(y^p_{thr}) = u^p(C_{ma}, h = 0; z).$$

A.4.3 Gift choice

Healthy or informal care: $s = 0$ *or* $h = 1$. We first state the optimal transfer choice for the case in which the parent is healthy or informal care was chosen in Stage 1. The solution is exactly as in Barczyk & Kredler (2014*a*). Following them, we first define the optimal unconstrained and constrained gifts

$$g^i_{unc} \equiv \max\left\{0, \min\{g^i_{dict}, c^j_{unc} - y_{j,2}\}\right\},$$
$$g^i_{constr} \equiv \max\left\{0, \min\{g^i_{stat,dict}, c^j_{unc} - y_{j,2}\}\right\},$$

where $g^i_{dict} \in (-\infty, \infty)$, $g^i_{stat,dict} \in (-\infty, \infty)$ and $c^i_{unc} \in (0, \infty)$ are implicitly defined by

$$V^i_{a^i} = \alpha^i u^j_c(y_{j,2} + g^i_{dict}, \cdot),$$
$$u^i_c(y_{i,2} - g^i_{stat,dict}, \cdot) = \alpha^i u^j_c(y_{j,2} + g^i_{stat,dict}, \cdot),$$
$$u^i_c(c^i_{unc}, \cdot) = V^i_{a^i}.$$

The subscripts "dict" indicate that the gift choices are the "dictator solutions" that a player would choose if she could impose her preferred allocation on the other. c^i_{unc} is the consumption level a player would choose if unconstrained. The optimal gift choices are then

$$\text{If } s = 0 \text{ or } h = 1: \quad g^i(z, V_a; y_2, h) = \begin{cases} 0 & \text{if } a^j > 0, \\ g^i_{unc} & \text{if } a^j = 0 \text{ and } a^i > 0, \\ g^i_{unc} & \text{if } a^j = a^i = 0 \text{ and } c^i_{unc} + g^i_{unc} \le y_{i,2}, \\ g^i_{constr} & \text{otherwise.} \end{cases} \tag{25}$$

Formal care: $s = 1$ *and* $h = 0$. We now analyze the gift choice under formal care, distinguishing the cases where the child is constrained and where it is not.

To make the parent choose PP, the child has to lift the parent's Stage-3 income above y^p_{thr}, see (24). Since $y_{p,3} = y_{p,2} + g^k$, this means that the smallest transfer that achieves this is $g^k_{thr} \equiv \max\{0, y^p_{thr} - y_{p,2}\}$. Any gift below this threshold is wasted, and it thus follows that the optimal gift on the interval $g^k \in [0, g^k_{thr})$ is $g^k = 0$.[64] On the interval $g^k \in [g^k_{thr}, \infty)$, we denote the optimal gift by g^k_{noMA}. Finally, the kid compares which out of $g^k \in \{0, g^k_{noMA}\}$ is better for her. We now go over two different cases, the unconstrained child and then the constrained child.

Case 1: child unconstrained ($a^k > 0$). Consider the situation when the child gives a transfer $g^k \geq g^k_{thr}$ that makes the parent choose PP. The kid's payoff function on this range, H^k_{noMA}, is then as in a setting without a consumption floor (see Barczyk & Kredler, 2014*a*). We define the Hamiltonian for this case (where there is no Medicaid) as

$$H^k_{noMA}(g^k) \equiv \alpha^k u^p\big(\min\{c^p_{unc}, y_{p,2}+g^k-p_{bc}+s_{pp}\}, h=0, z\big)+[y_{p,2}+g^k-p_{bc}+s_{pp}-c^p_{unc}]^+V^k_{a^p}-g^kV^k_{a^k},$$

where $[x]^+ \equiv \max\{x, 0\}$. As shown in Barczyk & Kredler (2014*a*), the function H^k_{noMA} is strictly increasing for $g^k < \tilde{g}^k$, and strictly decreasing for $g^k > \tilde{g}^k$, where

$$\tilde{g}^k = \max\big\{0, \min\{g^k_{dict}, c^p_{unc} + p_{bc} - s_{pp} - y_{p,2}\}\big\}.$$

The kid's payoff is increasing until the point where either g^k_{dict} is reached (which implements the kid's favored consumption allocation at this point in time) or the parent starts to save the gift. Thus, on the range $g^k \geq g^k_{thr}$, the optimal transfer is

$$g^k_{noMA} \equiv \arg\max_{g^k \geq g^k_{thr}} H^k_{noMA}(g^k) = \max\{g^k_{thr}, \tilde{g}^k\}.$$

Finally, we have to compare how the kid values the outcome under the best gift choice on the range $g^k \geq g^k_{thr}$ versus a transfer of zero. This gives us the kid's optimal transfer when the kid is unconstrained:

$$g^k_{f,unc} = \begin{cases} 0 & \text{if } \alpha^k u^p(C_{ma}, 0; z) \geq \alpha^k u^p(y_{p,2} - p_{bc} + s_{pp} + g^k_{noMA}, 0; z) - g^k_{noMA}V^k_{a^k}, \\ g^k_{noMA} & \text{otherwise.} \end{cases} \tag{26}$$

Note that in the case that the parent goes to MA when receiving no gift from the kid, this equation obviously gives the correct solution. If the parent does not go to MA given $g^k = 0$, then $g^k_{thr} = 0$. Thus $H^k_{noMA}(g^k_{noMA}) \geq H^k_{noMA}(0) \geq \alpha^k u^p(C_{ma}, 0; z)$, since the child will also prefer PP to MA if the parent chooses so herself in Stage 3 for $g^k = 0$. Thus the equation also gives the correct solution in this case.

[64]The interval $[0, g^k_{thr})$ is empty if $g_{thr} = 0$, in which case the parent chooses private care for any gift. In this case, only the interval $g^k \in [g^k_{thr}, \infty)$ is of interest.

Case 2: child constrained ($a^k = 0$). When the kid is also broke, we have to consider the possibility that the child is constrained. If the unconstrained-optimal gift from (26) is feasible, then $(c^k_{unc}, g^k_{f,unc})$ is obviously also the solution to the problem with the additional constraint. If the unconstrained-optimal policy is not feasible, the child will choose a transfer such that the constraint $c^k + g^k = y_{k,2}$ binds since the payoff is strictly concave (again, see Barczyk & Kredler, 2014*a*). To find the optimal transfer that fulfills $c^k + g^k = y_{k,2}$, consider the kid's payoff when the parent does not receive MA and the child is constrained:

$$\hat{H}^k_{noMA}(g^k) = \alpha^k u^p\big(\min\{c^p_{unc}, y_{p,2}+g^k-p_{bc}+s_{pp}\}, 0; z\big)+[y_{p,2}+g^k-p_{bc}+s_{pp}-c^p_{unc}]^+ V^k_{a^p}+u^k(y_{k,2}-g^k).$$

As Barczyk & Kredler (2014*a*) show, $\hat{H}^k_{noMA}(g^k)$ is strictly increasing for $g^k < \tilde{g}^k_{constr}$ and strictly decreasing for $g^k > g^k_{constr}$, where

$$\tilde{g}^k_{constr} \equiv \max\big\{0, \min\{g^k_{stat,dict}, c^p_{unc} + p_{bc} - s_{pp} - y_{p,2}\}\big\}.$$

Thus, the kid's optimal transfer among those that make the parent choose private care is

$$\hat{g}^k_{noMA} \equiv \arg\max_{g^k \geq g^k_{thr}} \hat{H}^k_{noMA}(g^k) = \max\{g^k_{thr}, \tilde{g}^k_{constr}\}.$$

We still have to consider an exception: It is not feasible for the child to give a transfer $g^k \geq g^k_{thr}$ if $y_{k,2} < g^k_{thr}$. In this case, any transfer from the child is wasted, thus $g^k = 0$ is optimal. If it is feasible for the child to pay g^k_{thr}, then she should again compare the payoff of giving $\hat{g}^k_{noMA}$ to that of zero transfers. To summarize, the child's optimal transfer when constrained is

$$g^k_{f,constr} = \begin{cases} 0 & \text{if } y_{k,2} < g^k_{thr}, \\ 0 & \text{if } y_{k,2} \geq g^k_{thr} \text{ and } \alpha^k u^p(C_{ma}, 0; z) + u^k(y_{k,2}) \geq \\ & \qquad \alpha^k u^p(y_{p,2} - p_{bc} + s_{pp} + \hat{g}^k_{noMA}, 0; z) + u^k(y_{k,2} - \hat{g}^k_{noMA}), \\ \hat{g}^k_{noMA} & \text{otherwise.} \end{cases} \tag{27}$$

Summary: child's optimal gift in formal care. Summarizing all cases, the child's optimal gift under formal care is

$$g^k(z : s = 1, y_2, h = 0) = \begin{cases} 0 & \text{if } a^p > 0, \\ g^k_{f,unc} & \text{if } a^p = 0 \text{ and } a^k > 0, \\ g^k_{f,unc} & \text{if } a^p = a^k = 0 \text{ and } c^k_{unc} + g^k_{f,unc} \le y_{k,2}, \\ g^k_{f,constr} & \text{otherwise.} \end{cases}$$

Parent's gift in formal care. Parents' optimal gifts are as in the case without formal care if $a^p > 0$, see Equation (25). If $a^p = 0$, then the parent cannot give gifts by assumption.

A.5 IC decision: Neither agent broke

Proof for Proposition 3.1: We start by writing down the surplus functions $S^p(Q)$ and $S^k(Q)$. Since we assumed $V^p_{a^p} > V^p_{a^k}$ and $V^k_{a^k} > V^k_{a^p}$, gifts in Stage 2 will be zero and the parent will not choose MA by assumption. Then we can write the laws of motion for wealth, (1) and (2), as functions of Q and h:[65]

$$\dot{a}^p(Q, h) = ra^p + y_p(\epsilon^p) - hQ - (1 - h)(p_{bc} - s_{pp}) - c^p(\cdot, h, m = 0),$$
$$\dot{a}^k(Q, h) = ra^k + h(Q + y_{k,ic} + s_{ic}) + (1 - h)y_{k,fc} - c^k(\cdot, h, m = 0).$$

Since $a^k > 0$, the optimal consumption rule (23) tells us that kid consumes the same in both scenarios in Stage 4, i.e. $c^k(\cdot, h = 0) = c^k(\cdot, h = 1)$. Thus also the kid's felicity $u^k(c^k(\cdot, h))$ is the same in both scenarios. For the parent, however, (23) tells us that she consumes C_f more in PP, i.e. $c^p(\cdot, h = 0) - c^p(\cdot, h = 1) = C_f$. But again, the parent's felicity is the same for $h = 0$ and for $h = 1$: Since the parent chooses consumption to set marginal felicity equal to $V^p_{a^p}$ in both cases, also the level of felicity must be the same due to the functional form of $u^p(\cdot)$.

Now, take the difference of the laws of motion between the two scenarios:

$$\dot{a}^p(Q, h = 1) - \dot{a}^p(Q, h = 0) = p_{bc} - s_{pp} - C_f - Q,$$
$$\dot{a}^k(Q, h = 1) - \dot{a}^k(Q, h = 0) = y_{k,ic} - y_{k,fc} + s_{ic} + Q.$$

Using these equations and the facts that the felicity is the same in the two scenarios for both

[65] Formally, use the laws of motion in H^k_4 in (4), and then recursively substitute into H^k_3, then into H^k_2, and finally into (11).

agents, we find that the surplus functions from (11) become

$$S^i(Q) = [p_{bc} - s_{pp} - C_f - Q]V^i_{a^p} + [s_{ic} - \underbrace{(y_{k,fc} - y_{i,fc})}_{=\Delta y_{ic}} + Q]V^i_{a^k} \qquad \text{for } i \in \{k, p\}. \tag{28}$$

Since we assumed $V^p_{a^p} > V^p_{a^k}$, $S^p(Q)$ is linearly decreasing in Q. By the same argument, $S^k(Q)$ is linearly increasing in Q since we assumed $V^k_{a^k} > V^k_{a^k}$. Setting $S^p(Q) = 0$ and $S^k(Q) = 0$ then yields the thresholds $\bar{Q}^p$ and $\underline{Q}^k$ claimed in the proposition. ■

Proof for Proposition 3.2. The claim on the form of the equilibrium care arrangement $h(z)$ follows directly from the properties of the surplus functions established in Proposition 3.1 and the definition of a bargaining solution in Equation (10). Since the surplus functions are linear, the equilibrium transfer Q^* is then given by the convex combination of the threat points using the bargaining weight ω, as is well-known. Formally, the expression for Q^* given in the proposition may be found by maximizing the Nash criterion in (12). ■

A.6 IC decision: General case

The following discussion of informal-care bargaining encompasses all cases, i.e. also vectors (a^p, a^k) where one or both players have zero wealth.

We will first analyze which transfers Q are too low in the sense that the parent would choose to top up the transfer Q with a gift $g^p > 0$ in Stage 2. It is useful to define the "dictator transfer" for the parent, $Q^*_p \in \overline{\mathbb{R}}$, which we back out from the (potentially negative) transfer that the parent would choose in IC if she had all family flow income in her pocket in Stage 2:

$$Q^*_p \equiv \begin{cases} g^p(z, V_a; [y_{p,2} = y_{p,1} + y_{k,ic}, 0], 1) - y_{k,ic} & \text{if } a^k = 0, \\ -\infty & \text{otherwise.} \end{cases} \tag{29}$$

When the kid has positive wealth, the parent always wants to receive an unbounded negative transfer flow since she prefers wealth to be in her pockets, $V^p_{a^p} > V^p_{a^k}$, and we define the desired transfer to be $-\infty$. Now, observe that for any transfer falling short of the optimum in Stage 1, $Q < Q^*_p$, the parent will give a gift $g^p = Q^*_p - Q$ in Stage 2 to attain her preferred allocation. This is true since all outcomes available after a transfer $Q < Q^*_p$ are also available to the parent when owning the family's entire flow income, which is how we constructed Q^*_p in the first place. In the transfer stage, we have thus shown that the parent's optimal strategy is

$$g^p = \max\{Q_p^* - Q, 0\}.$$

In a similar fashion, we now define an upper bound on transfers. Some transfers are so high that the kid would give back part of them as a gift. We define the dictator transfer for the child, $Q_k^* \in \overline{\mathbb{R}}$, from the gift the kid would give to the parent if the kid owned all of the family's flow income at the gift-giving stage:

$$Q_k^* \equiv \begin{cases} y_{p,1} - g^k(z, V_a; [0, y_{p,2} = y_{p,1} + y_{k,ic}], 1) & \text{if } a^p = 0, \\ \infty & \text{otherwise.} \end{cases} \tag{30}$$

Note that Q_k^* may be negative if $a^p = 0$. If the child has lots of resources, she may not want a transfer Q in exchange for IC but give a gift himself to prop up the parent's consumption. On the other hand, whenever the parent has positive wealth, the kid would like to receive an unbounded transfer flow since $V_{a^k}^k > V_{a^p}^k$.

We now show that $Q_k^* > Q_p^*$. If at least one of the players has positive wealth, this statement is obvious. For the case $a^p = a^k = 0$, imperfect altruism ($\alpha^k \alpha^p < 1$) implies that each player would choose the other to consume less than herself if she commanded all family flow income, resulting in the ideal transfer being larger for the kid than for the parent.

We now show that we only have to consider transfers $Q \in [Q_p^*, Q_k^*]$ to find the bargaining solution for informal care. First, we need not consider $Q < Q_p^*$, since the parent would react to such a low transfer by a gift in the gift-giving stage, lifting up the total amount given to the young to $Q + g^p = Q_p^*$. Thus any transfer $Q < Q_p^*$ will lead to the same consumption-savings allocation in Stage 4, and to the same bargaining surplus, as $Q = Q_p^*$. We thus may consider these transfers as equivalent and restrict the analysis to $Q \geq Q_p^*$. Second, any transfer $Q > Q_k^*$ would be "undone" by a gift from the children, leading to the same allocation and surplus as $Q = Q_k^*$.

We thus restrict the analysis to the interval $Q \in [Q_p^*, Q_k^*]$. On this interval, both S^k and S^p are monotone functions: the parent strictly prefers lower transfers and children prefer higher transfers, the bounds of the interval being their respective bliss points (if this was not the case, there would be gifts in the gift-giving stage). Now taking into account the non-negativity constraint on Q, we define the following bounds on the equilibrium transfer:

$$Q_{lb} = \max\{0, Q_p^*\}, \qquad Q_{ub} = \max\{0, Q_k^*\}. \tag{31}$$

If $Q_p^* < 0$, the ideal transfer for the parent is zero since we restrict Q to be non-negative. If, on the other hand, $Q_k^* < 0$, the child is so well off that she would give gifts to the parent in Stage 2 even if she receives no transfer for giving informal care. In this situation, the child will always implement her preferred allocation in Stage 2 and acts as a family dictator.

The following proposition is a full characterization of the informal-care decision.

Proposition A.1 (general characterization of informal-care decision) ***Proposition** (*general characterization of informal-care decision*): Let Q_p^* and Q_k^* be defined as in* (29) *and* (30)*, and let Q_{lb} and Q_{ub} be defined as in* (31)*. Then $Q_p^* < Q_k^*$, $S^p(Q)$ is a decreasing function for $Q \in [Q_p^*, Q_k^*]$, and $S^p(q)$ is an increasing function for $Q \in [Q_p^*, Q_k^*]$. In equilibrium the following cases can be distinguished:*

1. *(one bliss point undesirable) If $S^p(Q_{lb}) < 0$ or $S^k(Q_{ub}) < 0$, then $h = 0$.*
2. *(bliss points are desirable) If $S^p(Q_{lb}) \geq 0$ and $S^k(Q_{ub}) \geq 0$, then there exist thresholds $\underline{Q}^k \in [Q_{lb}, Q_{ub}]$ and $\bar{Q}^p \in [Q_{lb}, Q_{ub}]$ such that $S^k(Q) \geq 0$ iff $Q \geq \underline{Q}^k$ and $S^p(Q) \geq 0$ iff $Q \leq \bar{Q}^p$.*
   - *(a) (excessive reservation transfer) If $\underline{Q}^k > \bar{Q}^p$, then $h = 0$.*
   - *(b) (bargaining solution) If $\underline{Q}^k \leq \bar{Q}^p$, then $h = 1$ and*

     $$Q^* = \arg \max_{Q \in [\underline{Q}^k, \bar{Q}^p]} \{S^k(Q)^{1/2} S^p(Q)^{1/2}\}.$$

     Also, the parent will give no gifts in the ensuing stage of the game: $g^p = 0$. For the child, the following holds: if $Q_k^* \geq 0$ then $g^k = 0$, otherwise $g^k = -Q_k^* > 0$ and $Q^* = 0$.

Proof: $Q_p^* < Q_k^*$ and monotonicity of the functions S^p and S^k on the interval $[Q_p^*, Q_k^*]$ has been proved before. We now go over the different cases covered by the proposition, giving some explanations on the way.

1. If the parent is not willing to accept informal care even for the lowest-possible transfer, i.e. $S^p(Q_{lb}) < 0$, then $S^p(Q) < 0$ for all $Q \geq 0$ by monotonicity of the surplus function and thus no informal care takes place. Similarly, if the child is not willing to provide care for the highest-possible transfer, i.e. $S^k(Q_{ub}) < 0$, then no informal care takes place.

2. Consider now the case in which some transfer exists for each player under which they prefer IC. By increasingness of S^k, we can find the child's reservation transfer $\underline{Q}^k \in [Q_{lb}, Q_{ub}]$ at which S^k turns positive. Note that this reservation transfer is equal to Q_{lb} if $S^k(Q_{lb}) \geq 0$, and it equals zero if in addition $Q_{lb} = 0$. Similarly, by increasingness of S^p we can find $\bar{Q}^p \in [Q_{lb}, Q_{ub}]$, the parent's willingness to pay, above which S^p turns negative. This willingness to pay equals Q_{ub} if $S^p(Q_{ub}) \geq 0$. We can distinguish the following two cases according to the ordering of $\underline{Q}^k$ and $\bar{Q}^p$:

   (a) $\underline{Q}^k > \bar{Q}^p$: There is no Q such that both agents have a positive surplus and thus $h = 0$.

   (b) $\underline{Q}^k \leq \bar{Q}^p$: The surplus is positive for both agents on $Q \in [\underline{Q}^k, \bar{Q}^p]$, thus $h = 1$. We can find the Nash-bargaining solution Q^* evaluating the derivative of the Nash criterion in (12) with respect to Q. This derivative is easily shown to be a decreasing function on on $Q \in [\underline{Q}^k, \bar{Q}^p]$. Since $\bar{Q}^p \geq Q_{lb} \geq Q_p^*$, the parent will not give gifts in Stage 2. The following sub-cases can arise:

      i. $Q_{lb} = Q_{ub} = 0$: This case arises when the kid is not willing to accept a transfer $Q > 0$ from the parent, $Q_k^* \leq 0$, i.e. the kid would undo such a transfer by an altruistic gift. In this case we only have to check if both agents prefer IC to PP for $Q = 0$. Iff both prefer IC, then $h = 1$ and the child gives an altruistic gift in Stage 2.

      ii. $Q_{lb} = 0 < Q_{ub}$: The parent's bliss point is such that she would prefer not to give any transfer, i.e. $Q_p^* = 0$. In this case a corner solution $Q^* = 0$ may arise, which is characterized by the derivative of the Nash criterion being negative at $Q = 0$.

      iii. $0 < Q_{lb} < Q_{ub}$: In this case, there is an interior solution, which is identified by finding the zero of the derivative of the Nash criterion on (Q_{lb}, Q_{ub}).

Finally, we note that the case in which both players have positive wealth (which is discussed in the main text), is included in Point 2(b). In this case, $Q_p^* = -\infty < Q_{lb} = 0 < Q_{ub} = Q_k^*$, and the Nash-bargaining solution can be found in closed form. ■

A.7 Solution algorithm

As a starting point for our algorithm, define the value function of new parents entering retirement as $V^{ret}(a,\epsilon) \equiv V^p(0,a,0,\epsilon,\epsilon,0)$ – recall that these parents were just matched to a kid with the same productivity and with zero wealth. We will now make a guess for V^{ret} and then backward-iterate on age j^k until the value functions converge. We obtain the starting guess, V_0^{ret}, by solving our model for the retirement period of a parents household that faces the environment of our model but has no kids. Given the guess V_0^{ret}, the algorithm is:

1. From V_n^{ret}, we obtain the value functions $V^p(\cdot,j_{ret})$, $V^k(\cdot,j_{ret})$, and $W(\cdot,j^{ret})$ for $j^k = j^{ret}$, i.e. the last instant of interaction between kids and parents, from the boundary conditions (21) and (22).

2. Obtain value functions V_n^k, V_n^p, Z_n by backward-solving the HJBs (3) and (20) for ages $j^k \in [0,j^{ret}]$.

3. Obtain a new guess $V_{n+1}^{ret}(a,\epsilon) = V_n^p(0,a,0,\epsilon,\epsilon,0)$. Check if $V_n^{ret} \simeq V_{n-1}^{ret}$. Quit the loop if the convergence criterion is met, continue with step 1 if not.

Grid issues. We discretize the wealth variables a^k and a^p on a discrete grid. The discretization steps for age, Δj^k, are then endogenously chosen as the highest number that maintains all transition probabilities in the Markov-chain approximation within the bounds $[0,1]$ (this is equivalent to the stability criterion for finite-difference PDE methods). When parents die and leave large bequests, the kid's wealth jumps out of the state space. We extrapolate the value function Z outside the wealth grid in this case based on the assumption that consumption functions are linear.

Exchange-motivated transfers. In our computations, we impose an upper bound $Q_{max} < \infty$ on Q_k^* on the transfer Q. When the parent is wealth-rich but faces only a short time to live, children can essentially count on possessing all dynasty wealth within little time, and players become indifferent toward the timing of transfers. In such situations, players are essentially pooling their wealth, and the terms $V_{a^j}^i - V_{a^i}^i$ approach zero. This can lead equilibrium transfers to reach very high levels, see Equation (16), which has no implications on the allocation of care and consumption but slows down our algorithm considerably.

Altruistic gifts. Within step 2, we follow Barczyk & Kredler's (2014*a*) strategy. We guess that in equilibrium altruistic gifts only flow when the recipient has zero wealth, which requires that $V_{a^k}^k(z) \geq V_{a^p}^k(z)$ and $V_{a^p}^p \geq V_{a^k}^p(z)$ for all z. We ignore violations of these inequalities for all iterations $n < N$, where N is the final step in which convergence is reached. A challenge we face here is that by construction, we have $V^i_{a^i} = V^i_{a^j}$ for both agents at $j^p = j_{dth}$ when the parent dies for sure. A dollar in the parent's pocket has the same value as in the kid's pocket if it is bequeathed in the near future. Due to this, we find small violations to the transfer motives close to $j^p = j_{dth}$, which are probably due to numerical issues related to the discrete choices in our model.

Following Barczyk & Kredler (2014*a*), we have attempted to introduce Brownian noise into the laws of motion for a^k and a^p. However, introducing such noise did not help much to solve problems with the transfer motives, indicating that the main problem lies with the certain time of death. We have thus opted to leave out noise in order to have a simpler model.

We do not think that these issues pose a challenge to our computational strategy for the following reasons. First, the violations die off as we move away from $j^p = j_{dth}$, thus indicating that they are caused by the restriction that parents die for sure at j_{dth}. Second, the violations are infrequent and occur in places in the state space with almost zero measure of families.

B Calibration appendix

B.1 Health, mortality and medical-spending risks

Health and mortality. We first estimate stocks of LTC individuals $\lambda(j, ed)$ as a function of higher-order variables in age and interaction of age with education. We use a log-likelihood ratio test to pin down a desirable specification (among combinations of age, age-squared, education, and education interacted with age). Figure 3 shows the stocks of LTC individuals in the data by gender and educational attainment. Lower educated individuals have the lowest life expectancy and tend to require LTC at earlier ages. Additionally, their expected duration of LTC is longest.[66]

We then estimate transition probabilities for mortality by gender, health status, and educational attainment, shown in panels two and three of Figure 4. The preferred model for mortality hazards over a two-year interval for healthy individuals includes again age, age-squared, education, and education interacted with age, $\pi^{s=0}_{j+2}(j, ed)$. For LTC individuals, various statistical tests suggest that a model specification with only age and age-squared suffices, $\pi^{s=1}_{j+2}(j)$. To

[66]Cross-sectionally we also find that low-education individuals have more disability. We find that high-school dropouts above 65 years of age are roughly three times as likely to be disabled (according to our classification) than a college graduate above 65.

recover transition probabilities for LTC we make use of $\lambda(j, ed)$, $\pi_{j+2}^{s=0}(j, ed)$, and $\pi_{j+2}^{s=1}(j)$. Denote the stock of LTC individuals at age j and education level ed by $S(j, ed)$ and those who are healthy by $H(j, ed)$. By assumption, all individuals at age 65 are healthy. The pool of individuals alive A (the sum of healthy and sick) after a two-year period is

$$A(j+2, ed) = [1 - \pi_{j+2}^{s=0}(j, ed)]H(j, ed) + [1 - \pi_{j+2}^{s=1}(j)]S(j, ed).$$

The number of LTC individuals after two years is $S(j+2, ed) = \lambda(j+2, ed)A(j+2, ed)$. We can solve for the LTC transition probability $\phi(j, ed)$ from the law of motion of LTC individuals

$$S(j+2, ed) = (1 - \pi_{j+2}^{s=1}(j, ed))S(j, ed) + \phi(j, ed)H(j, ed).$$

Finally, we also need to update the stock of healthy individuals

$$H(j+2, ed) = (1 - \pi_{j+2}^{s=0}(j, ed))H(j, ed).$$

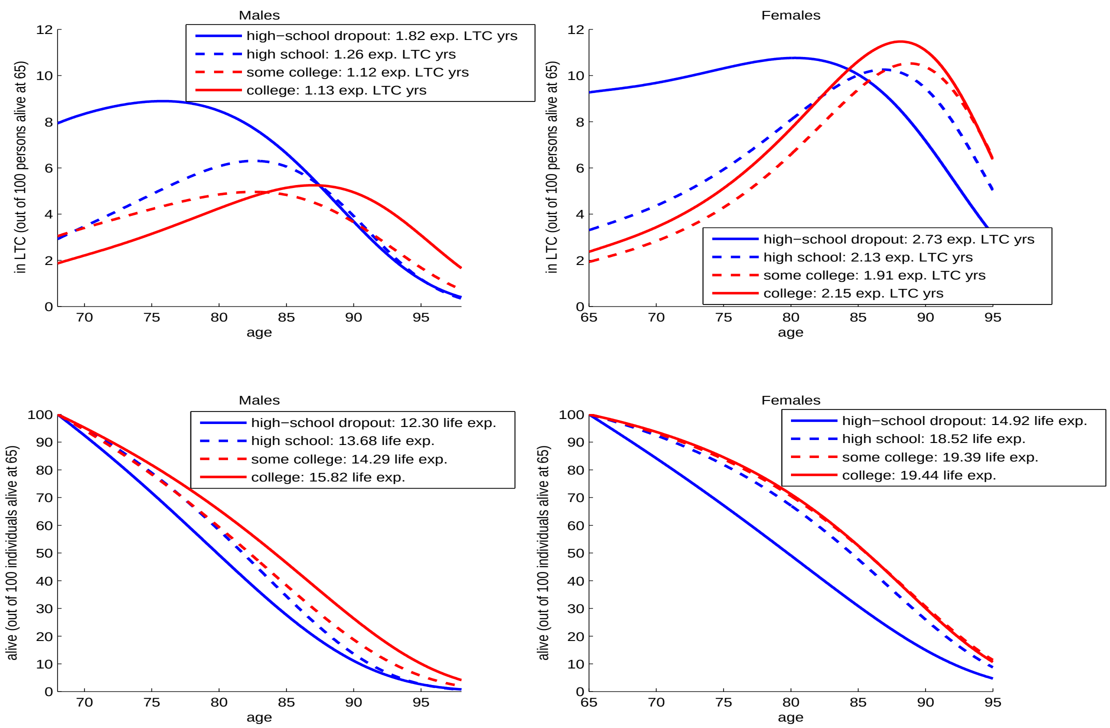
This estimation procedure yields conditional probabilities over a two-year time period. We need to convert these into yearly hazard rates, which we do by taking the matrix-logarithm of the estimated conditional probabilities. The top panel in Figure 4 shows the resulting LTC-risk profile.

In the model all individuals of age 65 are assumed to be healthy. Thus, when we estimate LTC and mortality hazards beginning with a pool of healthy individuals at age 65 we obtain a life expectancy which is somewhat higher and an expected duration of LTC slightly lower than is the case for all individuals in the data; Table 11 shows this comparison.

Medical spending. Medicare is a government health-insurance program that covers all individuals of age 65+ irrespective of income and wealth. Since we assume that medical shocks are exogenous and the Medicare policy remains invariant across the counterfactual experiments, we take this part out of the estimation of the shock process. Medicaid is a means-tested program that helps elderly individuals pay for expenditures that Medicare doesn't cover. Due to the means test, Medicaid costs to the government change endogenously when individuals change their savings behavior in response to policies. Thus we use pre-Medicaid costs in our estimation.

To estimate the pre-Medicaid medical expenditure process we follow KK and use observations that pertain to household heads in the top permanent-income quintile; permanent income is approximated by the sum of social-security benefits, employer pension plans and annuities.

Figure 3: Empirical stocks of LTC individuals



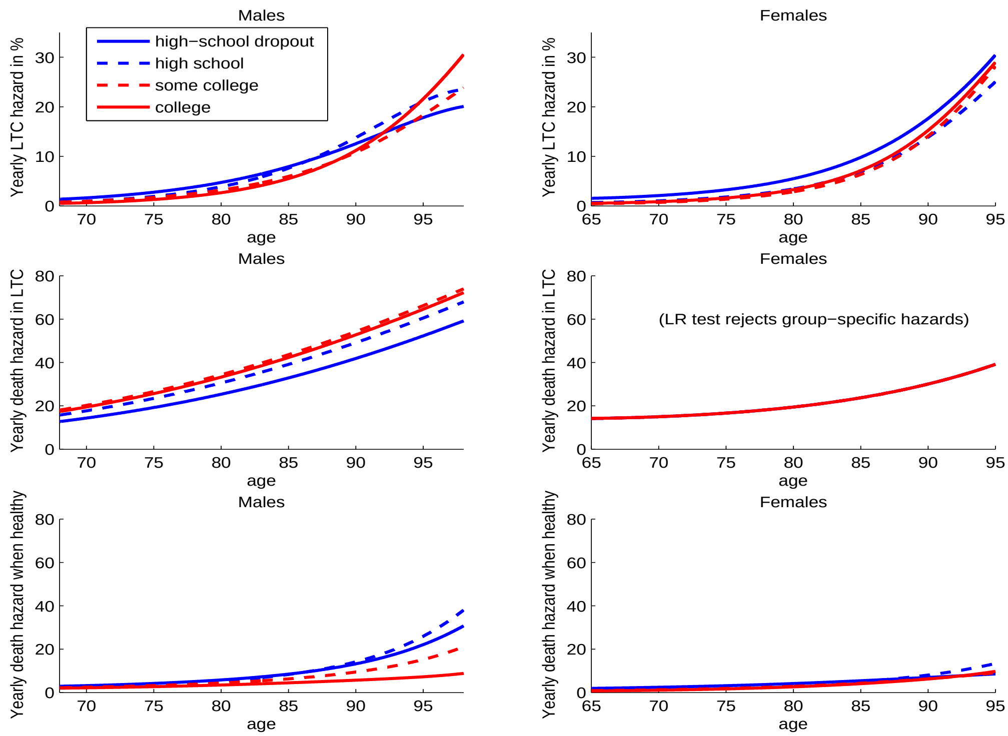
Data source: HRS waves 2000-2010.

The assumption is that OOP medical-expenditures are invariant across permanent income categories when conditioning on age. We study the following 5 categories from the HRS (including the exit interviews): hospital visits with overnight stays, outpatient surgery, doctor visits, prescription drugs, and home-health services (this does not include formal home care) for individuals of ages 65 and above.

Table 12 shows annualized medical OOP expenditures, and includes waves only after Medicare Part D had become effective. This piece of legislation, signed into law by the Medicare Prescription Drug Modernization Act in 2003, became effective in 2006 to alleviate OOP prescription drug costs. The impact of this policy on OOP prescription drug costs is clearly visible in the HRS data. For the purposes of the medical expenditure process we opt to use waves starting from 2006 on to get an estimation that is more in line with the situation current retirees face; see Table 10 in the Online Appendix for expenditures when also using prior years.

One point where we have to go beyond KK is the following. Note that to generate a fat-

Figure 4: Empirical and model hazards



Data source: HRS waves 2000-2010.

tailed distribution, as has been documented in the literature, in continuous time we cannot have individuals draw from a medical-shock distribution at each point in time as these shocks would average out by the law of large numbers.[67] Instead, to obtain a fat-tailed distribution, we need to assume that medical expenditures are lumpy (which also seems more realistic). In continuous time lumpiness is modelled through a jump process which is characterized by two objects: the hazard rate that a medical event occurs, and the distribution of medical costs conditional on the event occurring. To separately identify these two objects we proceed in the following way.

Hazard rate of medical event. We define a medical event to be a medical procedure which triggers a potentially large OOP expenditure. We find that a reasonable classification of a medical procedure to constitute as an event is if either a hospital visit with costs above an expenditure threshold occurs (which we set to $500), or if there is no hospital visit, there are

[67] In principal one could use Brownian disturbances to wealth to model medical shocks but such a process does not deliver fat tails even though it might occasionally generate very large expenditures.

Table 11: Life expectancy and expected LTC duration

Source	< high school	high school	some college	college
Data	14.92	18.52	19.39	19.44
Model	15.79	18.94	19.64	19.76

Data source: HRS waves 2000-2010. Females: life expectancy at age 65 by educational attainment.

Source	< high school	high school	some college	college
Data	2.73	2.13	1.91	2.15
Model	2.35	1.98	1.83	2.05

Data source: HRS waves 2000-2010. Females: expected duration of LTC, conditional on LTC, by educational attainment.

Source	< high school	high school	some college	college
Data	12.30	13.68	14.29	15.82
Model	12.86	13.94	14.60	16.03

Data source: HRS waves 2000-2010. Males: life expectancy at age 65 by educational attainment.

Source	< high school	high school	some college	college
Data	1.82	1.28	1.12	1.13
Model	1.48	1.15	1.01	1.07

Data source: HRS waves 2000-2010. Males: expected duration of LTC, conditional on LTC, by educational attainment.

Table 12: Medical expenditure

Statistic	hospital	outpatient surgery	doctor visits	drugs	home health
mean	$217	$59	$270	$1,228	$62
p50	0	0	0	$489	0
p75	0	0	$166	$1,305	0
p90	$163	0	$602	$2,844	0
p95	$862	$159	$1,587	$4,567	0
p99	$4,183	$1,241	$3,969	$11,131	$331

Data source: HRS 2006-2010 (including exit interviews). Annualized OOP expenditures for respondents of age 65 and above. Dollar figures converted into year 2000 values.

excess expenditure stemming from other procedures (again above $500 which typically accrue due to prescription drugs). We then count the number of events, n, that are observed during the interview interval length d, i.e. the duration since the last interview or 2 years if the last wave is lacking, for each individual. We find that a Poisson arrival model of rare events is an adequate description. Denote the (yearly) hazard rate of an event by $\zeta(j, g, s)$ which depends on age j, gender g and LTC status s (recall, we do this for the top permanent-income quintile). The hazard of events is assumed to be constant over the interval length d. Under the assumption of independence of events, n follows a Poisson distribution. It is characterized by the single

Poisson parameter $\phi = \zeta(j,g,s) \cdot d$. The expected number of events is then given by

$$\mathbb{E}(n|j,g,s;d) = \zeta(j,g,s) \cdot d \quad \Rightarrow \quad \frac{n}{d} = \zeta(j,g,s) + \epsilon,$$

and so to obtain estimated hazard rates we regress n/d (the number of events per year over the interview interval) on age, gender and our LTC indicator (we also include higher order terms for age). We find that a simple specification that only includes our measure of LTC, s, suffices (of course, this measure strongly correlates with age and somewhat less with gender).

OOP medical-cost distribution conditional on medical event. The second step is to estimate the distribution of post-Medicare pre-Medicaid OOP expenditures conditional on an event occurring. For this we use all observations with $n = 1$ (these constitute the majority of observations conditional on an event taking place) of individuals in the top permanent-income quintile. We find that, conditional on an event, the log-normal distribution gives a good fit and does so even for the upper tail.[68] Interestingly, we find that conditional on an event, individuals draw from the same distribution irrespectively of disability, age, and gender. This is also the case when using a fixed-effects regression as suggested by De Nardi et al. (2010).

Finally, we also include fixed medical spending for people above 65 years of age which we find to be \$185 per year.

B.2 Taxes

We model progressive income taxation using the functional form of Gouvieia & Strauss (1994). Total income taxes paid are

$$\tau(y) = b\left[1 - (sy+1)^{-1/p}\right],$$

where y is the taxable income of a household. We take the values for the parameters from estimates by Guner et al. (2014), who find $b = 0.264$, $s = 0.013$, and $p = 0.964$.

[68] Note that this is consistent with the existing literature that has documented even fatter tails than those generated by a log-normal distribution because individuals can draw multiple events over a two-year period, a time period which is used by, for example, De Nardi (2010).

We take the Social Security benefit schedule from Kopecky & Koreshkova (2014):

$$S(\bar{E}_\epsilon) = \begin{cases} 0.9\bar{E}_\epsilon, & \text{if } \bar{E}_\epsilon < 0.2\bar{E}, \\ 0.9(0.2\bar{E}) + 0.33(\bar{E}_\epsilon - 0.2\bar{E}), & \text{if } 0.2\bar{E} \leq \bar{E}_\epsilon \leq 1.25\bar{E}, \\ 0.9(0.2\bar{E}) + 0.33(1.25\bar{E} - 0.2\bar{E}) + 0.15(\bar{E}_\epsilon - 1.25\bar{E}), & \text{if } 1.25\bar{E} \leq \bar{E}_\epsilon \leq 2.46\bar{E}, \\ 0.9(0.2\bar{E}) + 0.33(1.25\bar{E} - 0.2\bar{E}) + 0.15(2.46\bar{E} - 1.25\bar{E}), & \text{if } \bar{E}_\epsilon > 2.46\bar{E}, \end{cases}$$

where $\bar{E}_\epsilon$ is average lifetime labor earnings, and $\bar{E}$ is the average economy-wide labor earnings. The Social Security tax rate is $\tau^{SS} = 0.124$.

C Scenario: Higher opportunity costs

Table 13, row "Status quo", shows results from a scenario where we lower β from 0.66 to 0.57, but maintain all other parameters as they are in the baseline calibration. Taking this as the new status quo, we then carry out the same counterfactuals as for the baseline in the rows below (using the same changes to the subsidy and MA parameters as before).

Table 13: Policy experiments with low β

	Care type (%)			**Costs (as $\Delta\tau$)**				**Wealth** ($000, age 70-75)			**Ex-ante CEV**	
LTC policy	IC	MA	PP	$\Delta\tau$ =	$\Delta\tau_s$ +	$\Delta\tau_{ma}$ +	$\Delta\tau_{lbr}$	p25	p50	p75	short run	long run
Status quo	33.7%	36.7%	29.6%					$56K	$189K	$361K		
$s_{ic}\uparrow$	43.5	31.1	25.4	0.15	0.21	-0.11	0.05	49	176	348	**0.180**	**-0.108**
$s_{ic}\uparrow$ (to young)	43.5	31.0	25.5	0.03	0.10	-0.11	0.04	51	178	350	0.132	-0.062
$s_{pp}\uparrow$	13.8	34.2	52.0	0.25	0.36	-0.05	-0.06	51	169	327	-0.125	-0.360
$s_{ic}\uparrow$ + $s_{pp}\uparrow$	27.3	29.3	43.4	0.32	0.49	-0.15	-0.02	45	160	317	**0.117**	**-0.372**
MA↑	29.8	43.4	26.7	0.22		0.23	-0.01	36	168	347	0.139	-0.402
MA↓	39.3	27.4	33.3	-0.25		-0.23	-0.02	85	213	374	-0.426	0.343
MA↓ + $s_{ic}\uparrow$	50.8	21.1	28.1	-0.08	0.23	-0.35	0.04	73	197	363	**0.000**	**0.349**

Policies: $s_{ic}\uparrow$: informal-care subsidy of $4,375 (per year). $s_{pp}\uparrow$: private-payer subsidy of $11,460 (per year). $MA\uparrow$: 20% increase to both y_{ma} and C_{ma}. $MA\downarrow$:20% reduction in both y_{ma} and C_{ma}. $s_{ic}\uparrow + s_{pp}\uparrow$: both informal- and formal-care subsidy, amounts as in $s_{ic}\uparrow$ and $s_{pp}\uparrow$. $MA\downarrow + s_{ic}\uparrow$: combination of $MA\downarrow$ and $s_{ic}\uparrow$. **Care arrangements**: IC: informal-care prevalence, MA: Medicaid prevalence, and PP: private-payer prevalence. **Costs**: $\Delta\tau$: change to the income tax rate required to finance LTC policy. Changes to tax rate due to: payout of subsidy $\Delta\tau_s$, changes in MA ($\Delta\tau_{ma}$), and change to income taxes ($\Delta\tau_{inc}$). Changes to government spending on medical shocks are negligible. **Wealth**: quantiles of wealth distribution ages 70-75. **CEV**: consumption equivalent of new-born under veil of ignorance. Short run: at time of reform (weighting with baseline measure over families), long run: after convergence (weighting with ergodic measure in counterfactual).

	IC transfers			**FC Financing**			**IC by kid educ**			**IC by parent pension**				
LTC policy	Exchg	Beqst	Altrsm	$g^k > 0$	$g^k = 0$	MA	HS	HS+	Collg	Q1	Q2	Q3	Q4	Q5
Status quo	88.1%	11.9%	0.0%	1.2%	43.5%	55.3%	54.4%	22.3%	0.0%	18.5%	31.5%	48.0%	44.1%	32.6%
$s_{ic}\uparrow$	74.5	25.4	0.1	1.5	43.5	55.0	66.3	34.0	0.0	26.9	47.8	56.6	52.1	40.2
$s_{ic}\uparrow$ (to young)	74.5	25.4	0.1	1.5	43.6	54.9	66.5	33.9	0.0	27.3	47.8	56.4	52.0	40.1
$s_{pp}\uparrow$	84.6	15.2	0.3	2.1	58.2	39.7	28.7	0.0	0.0	11.5	14.3	19.1	15.7	9.8
$s_{ic}\uparrow$ + $s_{pp}\uparrow$	90.0	9.8	0.3	2.6	57.1	40.3	56.8	0.2	0.0	22.3	36.3	34.2	28.0	18.3
MA↑	88.5	11.5	0.0	0.4	37.7	61.9	47.9	20.0	0.0	14.5	24.4	41.4	42.4	32.4
MA↓	87.0	13.0	0.0	2.2	52.7	45.1	65.0	23.8	0.0	25.7	45.8	53.1	45.0	32.6
MA↓ + $s_{ic}\uparrow$	73.7	26.2	0.1	2.9	54.2	42.9	79.3	37.4	0.0	46.6	56.5	60.7	52.7	40.2

IC Transfer: *Exchg*: IC with $g^k > 0$. *Beqst*: IC with $g^k = 0$, $a^p > 0$. *Altrsm*: IC with $g^k = a^p = 0$. **FC Financing**: PP care with $g^k > 0$, PP care with $g^k = 0$, MA care. **IC by kid educ**: IC among education groups; HS is high school; HS+ is more than high school and less than college. **IC by parent pension**: IC by parent pension quintile.