The Living Arrangement Dynamics of Sick, Elderly Individuals

Benoit Dostie
Pierre Thomas Léger

ABSTRACT

We model the dynamics associated with living-arrangement decisions of sick elderly individuals. Using the Panel Study of Income Dynamics' Parental Health Supplement, we construct the complete living-arrangement histories of elderly individuals in need of care. We use a simultaneous random-effects competing-risks model to analyze the impact of demographic characteristics, health, and wealth on the living-arrangement decisions of sick elderly individuals while taking into account state and duration dependence as well as unobserved heterogeneity. We find that the sick elderly individual's current living arrangement as well as the time spent in that living arrangement serve as important predictors of future living-arrangements.

I. Introduction

The demographic trend of an increasingly elderly population, both in absolute and relative terms, has put considerable upward pressure on medical and long-term care expenditures. Although many elderly individuals in need of care rely on nursing-home and formal in-home care, most rely on informal care provided by family members, including spouses and children.[1] Not surprisingly, a growing body

Both authors are assistant professors in the Institute of Applied Economics, HEC Montréal and CIRANO and CIRPÉE. *The authors are grateful to seminar participants at McGill, Laval, HEC Montréal, IRDES (Paris), SCSE (Montréal), CEA (Ottawa), 4e Journée d'économie publique LAGV (IDEP-Marseilles), CHESG (Banff), the HERO session at the ASSA meetings (San Diego), to Rob Clark and especially to two anonymous referees for their valuable comments. Both authors acknowledge funding from HEC Montréal. The data used in this article can be obtained beginning May 2006 through April 2009 from Pierre Thomas Léger, Institute of Applied Economics, HEC Montréal, 3000, chemin de la Côte-Sainte-Catherine, Montréal, Québec, Canada H3T 2A7; e-mail: ptl@hec.ca.*
[Submitted April 2004; accepted May 2005]
ISSN 022-166X E-ISSN 1548-8004

1. A fact highlighted in many studies including Stoller (1983); White-Means (1992); Kotlikoff and Morris (1990); Börsch-Supan, Gokhale, Kotlikoff, and Morris (1992).

of literature has examined the factors that affect living-arrangement decisions of elderly individuals in need of care. This literature has, however, generally ignored important dynamic elements in the living-arrangement decisions of sick elderly individuals, including the fact that many elderly individuals experience multiple living-arrangement spells and that these living arrangements appear to evolve over time. In response to this, we develop a dynamic model to analyze the living-arrangement decisions of elderly individuals in need of care. Our approach is to examine the actual transitions from one living arrangement to another, instead of, exclusively comparing individuals across different living arrangements at a given moment in time. As a result, we can analyze the impact of demographic characteristics, health, as well as state and duration dependence, on the likelihood of transiting from any one living arrangement to any other. Understanding the factors that affect the living-arrangement decisions of elderly individuals is necessary if we are to successfully predict future care requirements for an aging population. It is also a necessary first step if policies which seek to encourage particular forms of living arrangements are to be developed (for example, community-based rather than institutional-based living arrangements).

Many studies have examined the determinants of living arrangements of elderly individuals. Early work on this issue focused on predicting nursing-home stays (Branch and Jett 1982; Cohen, Tell, and Wallack 1986). These studies were later augmented in two significant ways. First, the set of living arrangements was expanded to include: (i) living independently (with or without a spouse), (ii) cohabiting with children, and (iii) living in a nursing home. Second, the role of children was incorporated into the decision-making process. Among the factors of interest to this literature are the role of sex, family composition, health and disability, as well as income and wealth, on the living-arrangement choices of elderly individuals. The literature has consistently shown that the probability of living in a nursing home relative to other living arrangements is greater for singles, decreases with the number of children (especially daughters) and wealth and increases with age and disabilities (Greenberg and Ginn 1979; Branch and Jett 1982; Cohen, Tell, and Wallack 1986; Garber and MaCurdy 1990; Stern 1996; Pezzin and Schone 1999; Hiedemann and Stern 1999; Engers and Stern 2002). It has also shown that the loss of a spouse and having more children increases the probability of cohabiting (Börsch-Supan, Kotlikoff, and Morris 1991). With respect to the role of gender, the literature has consistently shown that males are more likely to reside in a nursing home (Stern (1996); Garber and MaCurdy 1990; Hiedemann and Stern 1999) but has shown varied results with respect to its role on cohabitation and living independently (Börsch-Supan, Hajivassiliou, Kotlikoff, and Morris 1992; Hiedemann and Stern 1999).

Although much has been learnt from these studies, they are limited in several ways. First, they have generally assumed that living-arrangement decisions are made once and for all (or are made independently from one another). However, with a simple cursory look at the data we not only notice that many elderly individuals in need of care (henceforth referred to as the sick elderly) experience multiple living-arrangement spells, but that certain patterns (discussed in details below) suggest relationships between these living-arrangement spells.

The literature also generally compares individuals across different living arrangements at a particular moment in time (usually in a discrete-choice framework) instead of examining the actual choices that have brought the individual to his or her current living arrangement (that is, instead of estimating the living-arrangement transitions).[2] As a consequence, interpretations of the results may be difficult. As noted above, several studies found men, ceteris paribus, to be more likely to reside into a nursing home. However, this result does not necessarily imply that among those living independently, men are more likely to transit into a nursing home. Nor, does it necessarily imply that among those living in cohabitation, men are more likely to transit into a nursing home. The role of sex, as with other covariates, may have differing effects across different types of transitions. By comparing different individuals across different living arrangements instead of examining the actual transitions, the role of covariates is not allowed to vary across different types of transitions (to affect each conditional probability of leaving a particular living arrangement for another differently). As a consequence, models which ignore an individual's current living arrangement will have limited predictive power. If the current living arrangement is an important predictor of future living arrangement and the role of covariates is transition specific, then policies may need to be developed accordingly. For example, different policies which seek to reduce transitions into nursing homes may need to be developed separately for those currently living independently than for those currently cohabiting with their children.

Another potentially important element which has been ignored in the literature is duration dependence—the possibility that the time spent in a particular living arrangement affects the likelihood of leaving the current living arrangement as well as the likely destination.[3] Duration dependence is likely to be important, in particular, if the costs and benefits (both psychic and financial) of leaving a particular living arrangement for another change as the time spent in the current living arrangement increases. Thus, when examining an individual's likelihood of transiting to a particular living arrangement, one may want to consider not only where he or she currently resides (state dependence) but also how long he or she has lived there (duration dependence).

In this paper, we address the dynamics associated with living-arrangement decisions of sick elderly individuals. We first construct complete living-arrangement histories using the Panel Study of Income Dynamics' (PSID) Parental Health Supplement (PHS) which focuses on sick elderly individuals. We then formulate and estimate a model which allows us to consider all types of living-arrangement transitions and multiple living-arrangement spells. More specifically, we use a duration framework to estimate the impact of demographic and health characteristics on the time spent in a particular living arrangement. Because transitions from a current living-arrangement can occur at any time (and to any alternative living arrangement), we use a simultaneous random-effects competing-risks model. Furthermore, because

2. Notable exceptions are Börsch-Supan, Kotlikoff, and Morris (1991) who examine, within a discrete-choice setting, a subset of potential transitions using four waves of the Hebrew Rehabilitation Center for the Aged potential (HRCA) and, Garber and MaCurdy (1990) who examine entry and exits (and duration) into nursing-home care exclusively.

3. Heiss, Hurd, and Börsch-Supan (2003) examine the relationship between living arrangements, health and economic status. However, their predicted living-arrangement trajectories are based on the results of a multinomial logit model where: (1) there is no individual specific unobserved heterogeneity, (2) no duration dependence, (3) transition probabilities are not allowed to differ according to the origin state, and (4) initial conditions are not modelled. Also, because the initial sample contained noninstitutionalized elderly individuals exclusively, transitions into and out of nursing homes are limited.

we observe an individual through multiple living-arrangement spells, we control for individual unobserved heterogeneity assuming stochastic variation in the transition rates.

As noted above, our econometric framework also allows us to simultaneously estimate living-arrangement-specific duration dependence which provides information on the stability of each living-arrangement; something that has, to our knowledge, not been done before. We are also able to verify whether previous results with respect to the impact of demographic and health factors on living-arrangement decisions are robust to duration dependence, unobserved heterogeneity and the competing risks of transitions into other types of living arrangements, death or censoring.

Results presented below underscore, among other things, the importance of age, state, and duration dependence in the living-arrangement decisions of sick elderly individuals. For example, we show that sick elderly individuals are more likely to transit out of independence as they grow older yet are less likely to return to independence as the time spent in cohabitation or nursing home increases. Our results also suggest that the roles of covariates are in fact transition specific. For example, female elderly individuals are more likely to transit from independent to nursing home, yet less likely to transit from cohabitation to nursing home than are their male counterparts. The same can be said of married individuals relative to single individuals. Results such as these suggest that public policies may be more effective if they are targeted towards particular individuals. For example, a policy which seeks to encourage community-based care instead of institutionalization may be more effective if they are targeted towards the type of individuals most at risk of transiting into nursing home care; where the at-risk population may be different when looking at those currently living independently than when looking at those currently cohabiting and, which may change over time.

The remainder of the paper is organized as follows. In Section II we present details of the data set and summary statistics on living-arrangement transitions and durations. In Section III we develop the econometric model. Results are presented in Section IV. Conclusions are drawn in Section V.

II. Data and Summary Statistics

The data used in this paper are drawn from the Panel Study of Income Dynamics' Parental Health Supplement of 1991. In 1988, PSID households were asked some basic questions about their parents (living and/or deceased). This initial information formed the basis of the Parental Health Supplement which was administered to PSID households in 1991. To be eligible for the PHS, at least one of the PSID Head of household's (or spouse's) parents had to be: (i) 70 years of age or older in 1991, or (ii), in the case of a deceased parent, to have died after 1980 at 70 years of age or older. The PHS includes 1,650 eligible "fathers" and 2,008 eligible "mothers."[4]

In an attempt to identify parents who were in need of care, the PSID head of household and their spouse were asked if their parent(s) had reached the point where they could no longer be expected to live independently and take care of their own daily

4. Fathers may either be the PSID Head of household's father or the spouse's father. Similarly, mothers may either be the PSID Head of household's mother or the spouse's mother. Thus, each PSID family may have at most four parents who qualify for the Parental Health Supplement.

needs without extra help, at any time between 1975 and 1991 (henceforth, we will refer to the date when the elderly parent reached such a point as the sick elderly parent's "time-of-illness"). Of the 1,650 eligible fathers, 410 of their adult children identified them as having reached such a needs threshold at 50 years of age or older. Similarly, the adult children of 554 of 2,008 eligible mothers identified them as having reached such a needs threshold at 50 years of age or older. These 964 individuals constitute the sample we use for the remainder in the paper.[5,6]

If a parent had reached such a needs threshold, a retrospective questionnaire was administered to the head of household or spouse (the adult child) about each parent. Information was collected about: (i) whether the parent suffered from a series of particular illnesses, (ii) whether the parent was able to perform a series of basic tasks, (iii) where the parent resided (and for how long), (iv) how many living children the parent had, and (v) parental age and marital-status.[7] This information was collected for various points in time during the parent's history. Because dates were given for each parent's transition from one type of living arrangement to another (as well as information collected about the parent and his or her family at the time of each transition), we are able to construct the full living-arrangement history of each parent up to their death or up to 1991.[8,9] As a result, the PHS lends itself

5. As noted above, the eligibility requirements of the PHS required that at least one of the parents of the PSID Head of household (or spouse): (i) was 70 years of age or older in 1991, or (ii) had died after 1980 at 70 years of age or older. Parents from both groups (for example, who became eligible because of (i) or (ii)) are quite similar, with respect to their age at the time-of-illness (the average age at the time-of-illness for the first group is 77.8 while the average age at the time-of-illness of the later is 78.8). These two groups are also very similar to each other with respect to a variety of variables (including health indicators and the number of children). Because of the eligibility rules, however, individuals from the first group required help at a later date, on average, than the latter group (1988 and 1985, respectively).

6. The initial sample included 1,025 individuals. The difference between this number and the 964 individuals that constitute our sample, are the individuals who were excluded either because they had undefined living arrangements or because they were cohabiting prior to their time-of-illness. We exclude individuals who cohabited prior to their time-of-illness, because their living arrangement, although shared, is likely to be very different in nature than post time-of-illness cohabitation. Including these individuals and treating them as "independent' prior to the "time-of-illness" does not change the qualitative results presented below. Individuals in our sample went through 1,576 transitions. For some of the spells, however, we have missing values for some of the covariates. In fact, we have complete information on covariates for only 590 transitions. This is mainly due to missing values on the variables *eating* and *walking* for which we have information exclusively at the time of illness, at the time of death or in 1991. We therefore perform the following imputation procedure: we assume that these health indicators (*eating* and *walking*) are constant (after the time of illness) unless we have updated information. This imputation affects about 900 spells which leaves us with 1449 transitions on which to perform our analysis.

7. The PHS questionnaire includes some basic information on parental wealth. However, we do not use this information because: (i) of the way it was coded and because of the large proportion of individuals who did not report their parent's wealth, and (ii) it is likely to be endogeneous to the living-arrangement decision.

8. One of the limitations of the PHS is related to the fact that the questionnaire is answered by the children of the individuals in question and may suffer from recall issues. Although recall based survey data may often exhibit measurement error, studies have shown that the accuracy of such data is good for important events such as marital, fertility and major employment episodes (Dex (1991)). Given that the survey questions in our data set are centered around major events (for example, living-arrangement transitions of elderly parents), recall is unlikely to be an important issue.

9. Of the 410 sick elderly fathers, 292 had died prior to, or in, 1991. As a result, we observe the full living-arrangement history of 71 per cent of the fathers in our sample while the rest are censored in 1991. Similarly, 55 per cent of the sick elderly mothers have complete living-arrangement histories while the rest are censored.

well to both the analysis of parental living-arrangement decisions as well as their durations.[10]

As in the previous literature, we focus on three different types of living arrangements: (i) independent living with or without a spouse,[11] (ii) cohabiting with a family member (for example, with a child or child-in-law), and (iii) living in a nursing home.[12]

At the time-of-illness, 25.3 per cent of fathers entered a nursing home, 20.7 per cent of fathers moved-in with a child (cohabitation), while 43.2 per cent of fathers remained in independent living.[13] Although some fathers remain in these living arrangements until their death or until they are censored in 1991, many others experience subsequent transitions into other types of living arrangements. The full living-arrangement histories of sick elderly fathers are summarized in Figure 1. Mothers in the PHS appear to behave differently from fathers. For example, of the sick elderly mothers, 33 per cent entered a nursing home (compared with 25.3 per cent of fathers) at the time-of-illness. This somewhat larger proportion may be partially due to the fact that women often outlive their spouse and are thus unable to benefit from a potentially important source of care. Furthermore, 33.8 per cent of mothers moved in with someone (cohabit) at the time-of-illness, while 25.8 per cent of mothers remained in independent living at that time.[14] Again, the fact that mothers appear to rely more heavily on cohabitation and are less likely to remain independent may be due to the lack of a healthy, living spouse for caregiving. The full-living arrangement histories of mothers are summarized in Figure 2.

Another important element in the figures is the percentage of individuals who transit out of an initial living arrangement. For example, in our sample, 12.5 per cent of

10. One of the strengths of the PHS is that the living-arrangement histories are not left censored (that is, we observe the individual prior to their inability to take care of themselves). Another strength is that it includes information on all living-arrangement transitions including very short spells (which are rather frequent). These two advantages are not present in panel data sets such as the Assets and Health Dynamics for the Oldest-Old (AHEAD). In AHEAD, the first wave only includes individuals who resided in the community. Thus, it likely over-selects healthy individuals in the first wave (that is, those who are not institutionalized) and the proportion of individuals who reside in a nursing home in subsequent waves is smaller than in the population. Furthermore, because AHEAD is a panel which interviews individuals every two years and does not include retrospective questions with respect to cohabitation, many living arrangement spells are likely missing (for example, AHEAD will not record an individual who transited from independent living to cohabitation back to independent living if the transitions occurred between two waves).

11. In this type of living arrangement, some received formal in-home care, while other received informal in-home care provided by family and friends including spouses and children.

12. We exclude hospital stays as a type of living arrangement in the econometric analysis. This is because hospitalization episodes are only recorded in the questionnaire if they immediately predated a living-arrangement transition. Thus, for example, if an individual went to the hospital from independent living and returned to independent living afterwards, the hospital stay was not recorded. Because we likely observe only a small subset of hospital stays we cannot include them as a separate living arrangement nor can we use them to predict living-arrangement transitions. With respect to hospital stays which occurred during a transition (that is, between two different living arrangements), they are assumed to be part of the initial living arrangement.

13. The rest of the fathers (9.3 per cent) entered a hospital at the time of illness, where they remained until their death.

14. 7.4 per cent of the mothers entered a hospital at the time illness, where they remained until their death.

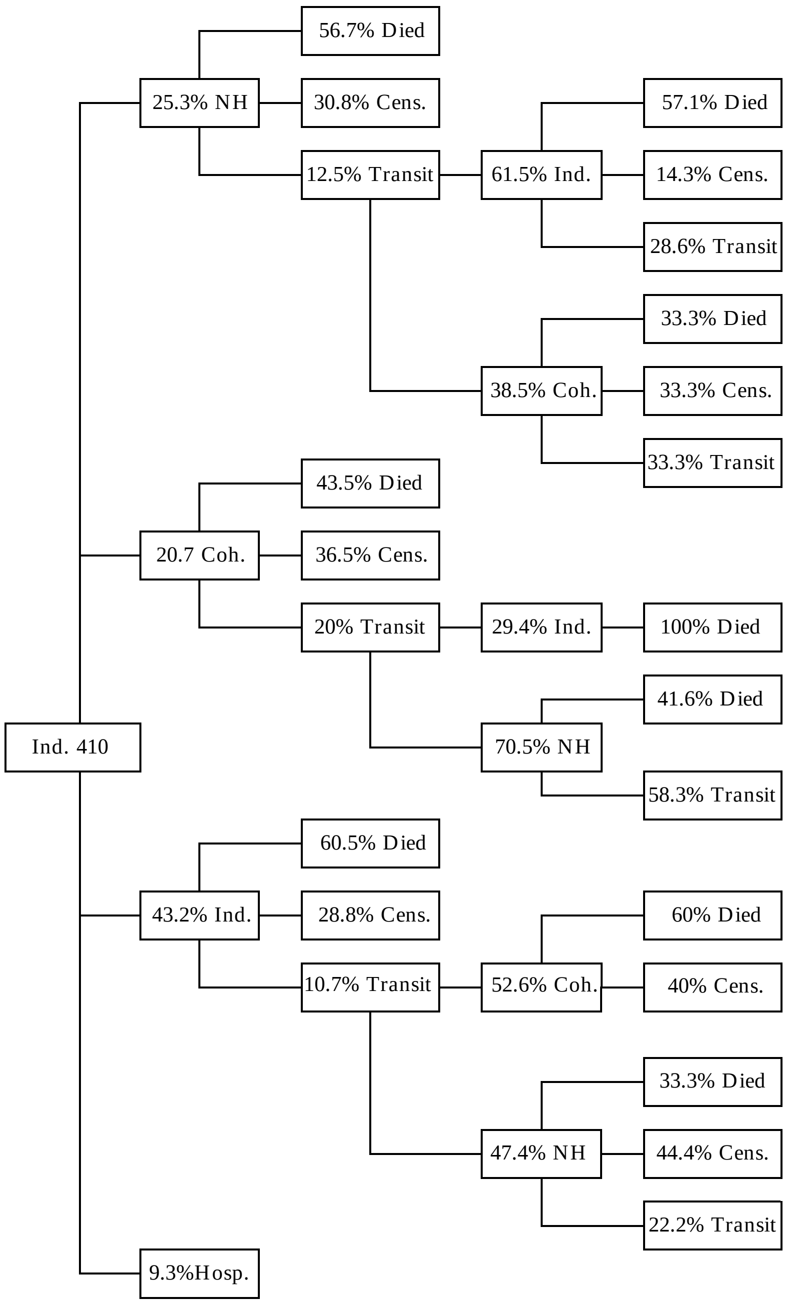

Figure 1
Living Arrangement Histories for Fathers

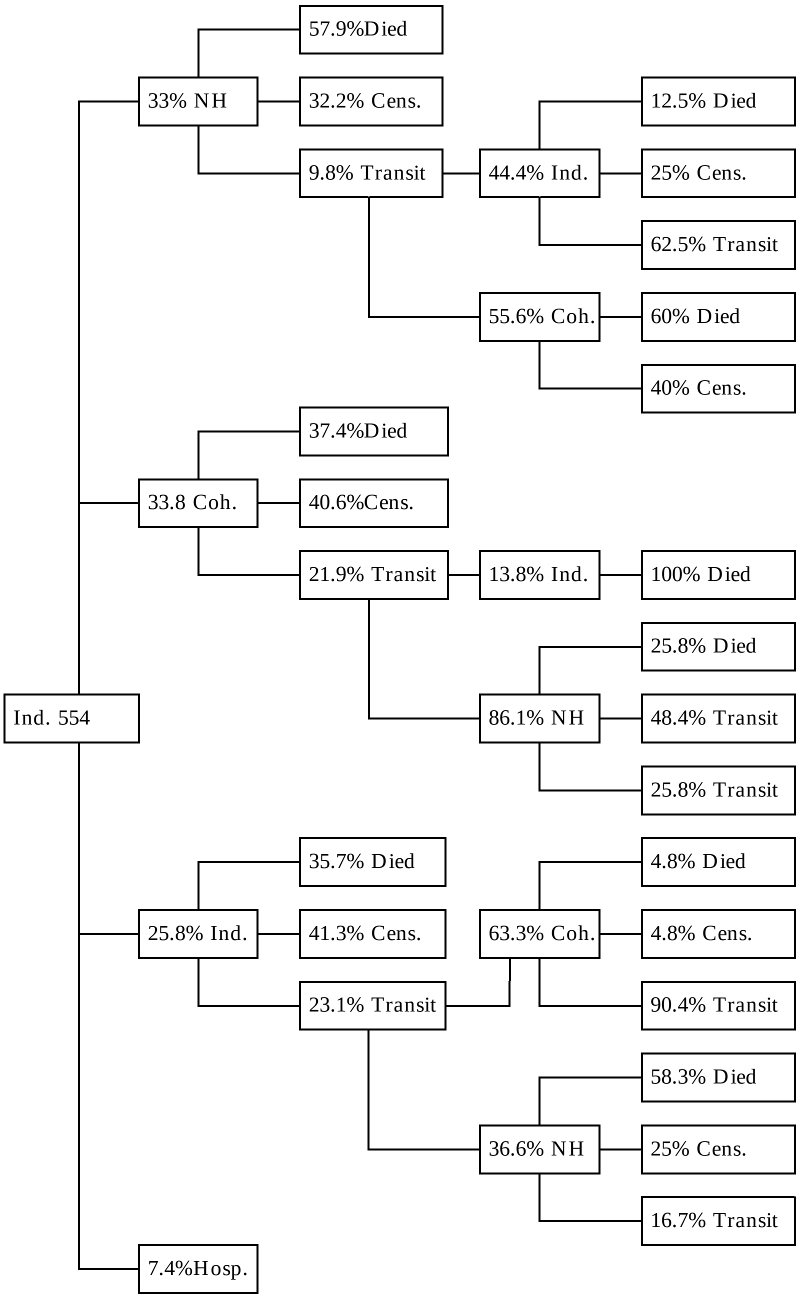

Figure 2
Living Arrangement Histories for Mothers

fathers and 9.8 per cent of mothers are observed transiting out of an initial nursing-home stay. It is, however, important to note that a large proportion of both fathers and mothers are censored in nursing-home care (that is, we do not observe whether or not they ultimately transit out of nursing-home care). Thus the percentage of actual transitions out of an initial nursing-home stay is likely to be greater. Transitions out of an initial cohabiting or independent living arrangement are, not surprisingly, more common. For example, 20 per cent of fathers and 21.9 per cent of mothers are observed transiting out of an initial cohabiting stay. Consequently, even in the presence of censoring, a considerable percentage of individuals transit out of their initial living arrangement. Another important element that should be highlighted in these figures is the means by which individuals ultimately end up in a particular living arrangement. For example, many individuals enter a nursing home via cohabitation. As a result, cohabitation may serve both as a substitute and a lead-in to institutionalization. These initial results not only indicate that living-arrangement decisions may be made more than once but also suggest that they are not made independently from one another.

Summary statistics on the living arrangements at the time-of-illness for fathers and mothers (including information on their duration in days) are presented in Tables 1 and 2, respectively. Duration data suggest that mothers experience considerably longer lengths of stays across all types of living arrangements. For example, if we compare the three different living arrangements (excluding hospital stays) for mothers and fathers who died in their first living arrangement, we find that mothers have a much longer average length of stay in nursing home (1,265 days compared with 897);

Table 1
Fathers

Living Arrangement	Per cent	Minimum Duration*	Maximum Duration	Average Duration
1) Hospital stay†	9.3%			
2) Nursing home	25.3%			
Censored	30.8% (of 25.3%)	30	510	250.3
Died there	56.7% (of 25.3%)	0	2,790	897.8
Transited	12.5% (of 25.3%)	9	1,825	268.5
3) Cohabitation	20.7%			
Censored	36.5% (of 20.7%)	30	450	236.7
Died there	43.5% (of 20.7%)	390	2,460	761.9
Transited	20.0% (of 20.7%)	7	2,555	394.8
4) Independent	42.4%			
Censored	27.5% (of 42.4%)	30	750	235
Died there	61.5% (of 42.4%)	0	4,470	973.1
Transited	10.9% (of 42.4%)	14	2,555	402.9

† Hospital Stays are coded as a living arrangement exclusively for those individuals who entered a hospital and died there (they are excluded in the analysis below).
* Durations measured in days.

Table 2
Mothers

Living Arrangement	Per cent	Minimum Duration*	Maximum Duration	Average Duration
1) Hospital stay†	7.4%			
2) Nursing home	33%			
Censored	32.2% (of 33%)	60	660	281.6
Died there	57.9% (of 33%)	0‡	9,090	1,265.2
Transited	9.8% (of 33%)	2	730	144.6
3) Cohabitation	33.8%			
Censored	40.6% (of 33.8%)	30	630	262
Died there	37.4% (of 33.8%)	360	10,380	1,414.1
Transited	21.9% (of 33.8%)	3	5,475	1,012.8
4) Independent	25.3%			
Censored	40% (of 25.3%)	30	960	274
Died there	36.4% (of 25.3%)	390	9,480	1,645
Transited	23.6% (of 25.3%)	21	5,475	573.1

† Hospital Stays are coded as a living arrangement exclusively for those individuals who entered a hospital and died there (they are excluded in the analysis below).
* Durations measured in days.
‡ Zeroes indicate death in the same month.

cohabitation (1,414 days compared with 761.9); and independent living (1,645 days compared with 973). Women may have longer nursing-home and cohabiting stays because they live longer and are more likely to outlive their spouse (or because male spouses may be less able or willing to care for their ailing wives). They might also have longer independent-living durations because they are better able to care for themselves without the full-time use of informal and formal care.

Table 3 provides labels for variables (covariates) that are used in our analysis while Table 4 presents summary statistics for these covariates by transition types (except hospital stays) at the time-of-illness. As is apparent, the mean value for a given covariate varies greatly by transition type. To cite just a few examples, mothers appear to transit more often from independent to nursing home and cohabitation. Furthermore, individuals who remain independent or transit to cohabitation have, on average, more children than those who transit to nursing home. Individuals who transit into nursing home are, ceteris paribus, older and are more likely to have suffered from memory problems (as well as more likely to have suffered a stroke) than those who remain independent or transit into cohabitation. Because the role of covariates appears to be transition specific (that is, entry-exit pair specific), we present in the next section an econometric model that takes into account the different types of transitions.[15]

15. Although certain covariates of interest such as insurance status are not available in the data set, our econometric specification treats them as time-invariant unobservables.

Table 3
Variables Description

Demographic information	
Mother	Dummy variable: 1 for mothers
NumChild	Number of children
Rural	Dummy variable: 1 if rural
Married	Dummy variable: 1 if married
Health: difficulties with Activities of Daily Living (ADL)	
Eating	Dummy variable: 1 if difficulties with eating alone
Walking	Dummy variable: 1 if difficulties with walking
Hearing	Dummy variable: 1 if difficulties with hearing
Seeing	Dummy variable: 1 if difficulties with seeing
Think	Dummy variable: 1 if difficulties with thinking
Health: illnesses	
Heart	Dummy variable: 1 if heart problems
Angina	Dummy variable: 1 if angina problems
Kidney	Dummy variable: 1 if kidney problems
Contbow	Dummy variable: 1 if problems controlling bowels
Stroke	Dummy variable: 1 if individual had a stroke

III. Econometric Specification

As discussed in the previous section, we have information on the complete living-arrangement histories of elderly individuals starting at their time-of-illness date. As a result, we are able to study the impact of different covariates (including demographic and health indicators) on the time spent in different living arrangements using a duration framework. This framework also allows us to take into account duration dependence (that is, the possibility that the transition into alternative living arrangements depends on the time spent in the current living arrangement). Allowing for duration dependence is not possible in typical discrete choice models.

A limitation of standard duration models is that they do not allow the impact of covariates to vary across potential exit states. This, however, is likely to be very restrictive when examining the living-arrangement transitions of sick elderly individuals. For example, one might expect that having more children would delay the transition from independent living to nursing home while simultaneously accelerating the transition from independent living to cohabitation. Consequently, we extend the basic duration model to a competing-risks framework.[16]

A competing-risks model is a duration model in which the observed duration is the shortest of a number of latent durations. Each latent duration corresponds to a particular type of spell, where the observed spell and transition correspond to the shortest

16. See Crowder (2001) for a general treatment of competing-risks models or Dolton and van der Klaauw (1999) and Mealli and Pudney (1996) for detailed recent examples.

Table 4
Summary Statistics at Time-of-Illness

	Stayed Independent N = 365		Transited to Nursing home N = 276		Transited to Cohabitation N = 243	
	Mean	Standard Devision	Mean	Standard Devision	Mean	Standard Devision
Demographic information						
Mother	0.427	0.495	0.638	0.482	0.683	0.466
NumChild	4.148	2.862	3.663	2.269	4.646	2.897
Rural	0.356	0.48	0.351	0.478	0.354	0.479
Age	78.055	7.555	80.844	7.554	77.909	7.888
Married	0.696	0.461	0.337	0.474	0.243	0.430
Health: difficulties with Activities of Daily Living (ADL)						
Eating	0.285	0.452	0.304	0.461	0.239	0.427
Walking	0.441	0.497	0.500	0.501	0.370	0.484
Hearing	0.367	0.483	0.344	0.476	0.267	0.444
Seeing	0.290	0.455	0.268	0.444	0.329	0.471
Think	0.405	0.492	0.569	0.496	0.428	0.496
Health: illnesses						
Heart	0.427	0.495	0.330	0.471	0.346	0.477
Angina	0.241	0.428	0.188	0.392	0.230	0.422
Kidney	0.142	0.350	0.083	0.277	0.091	0.288
Contbow	0.151	0.358	0.315	0.465	0.230	0.422
Stroke	0.310	0.463	0.409	0.493	0.267	0.444

of the aforementioned latent durations. The competing-risks specification is required because the process underlying each type of living-arrangement transition is likely to be different; implying different covariate effects and different duration dependence for each type of transition. These separate effects are confounded in single risk analyses of living-arrangement spells.

Because we observe an individual through multiple living-arrangement spells, we estimate a competing-risks model for each possible living arrangement. Simultaneity between the competing-risks models is achieved by including an individual-specific random-effects component that also takes into account unobserved heterogeneity.[17] The random effect allows us to take into account unobserved person-specific heterogeneity in transition intensities. It also allows dependence between spell durations in different states (for example, if the random component reflects taste for stability, durations across different states could be positively correlated).

17. This simultaneous random-effects competing-risks model can be interpreted as a finite-state continuous-time Markov model (Lancaster (1990)).

Formally, let $Y(t)$ represent the state (the living arrangement) of the elderly individual at time t. $Y(t)$ can take four values: (1) living in a nursing home, (2) living independently (3) cohabiting, and (4) death. Transitions between states are determined by a matrix of transition intensities. That is, given that state b ($b \in \{1,2,3\}$) is entered at calendar time t and is still occupied at $t + s$, the transition out of b is determined by the set of 3 transition intensities $h_{be}(t, s)$ (where $e \in \{1,2,3,4\}$ and $e \neq b$). As a consequence, $h_{be}(t, s)$ds gives the probability of a departure from state b to state e in the short interval from $t + s$ to $t + s + ds$. This probability is conditional or being in b for a duration of s. The matrix of transition intensities between the four states takes the form

$$(1) \quad \begin{bmatrix} 1-h_1 & h_{12} & h_{13} & h_{14} \\ h_{21} & 1-h_2 & h_{23} & h_{24} \\ h_{31} & h_{32} & 1-h_3 & h_{34} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

where we define

$$(2) \quad h_b(t) = \sum_{\substack{b \neq e \\ e}} h_{be}(t)$$

to be the probability of exiting state b. The diagonal terms in Equation 1 define the probabilities of staying in the each of the current living arrangements. The special structure of the last row reflects that fact that death is an absorbing state, that is, the probability of remaining dead is one and the probability of transiting from death to any other living arrangement is zero.

To build the likelihood function, we assume that the probability density function of the time spent in each living arrangement takes the generalized Gompertz form.[18] The Gompertz distribution gives rise to a very convenient form for the hazard rates or transition intensities: the log-hazards are linear in the covariates of interest. Specifically,

18. We say that t follows the Gompertz distribution when its density function takes the form:

$$f(t) = e^{(\lambda + \gamma t) - \frac{e^{\lambda}}{\gamma}(e^{\lambda t} - 1)}.$$

The survivor function is

$$S(t) = e^{\frac{-e^{\lambda}}{\gamma}(e^{\lambda t} - 1)}.$$

and the hazard rate is written as

$$h(t) = e^{\lambda} e^{\gamma t}$$

or

$$In\, h(t) = \lambda + \gamma t.$$

The model is implemented by parametrizing $\lambda = \beta X$. Thus, in its most basic form, we write a Gompertz hazard as

$$ln\, h(t) = \gamma T(t) + \beta X.$$

we let the transition from living arrangement b to living arrangement e take the following form:

(3) $$\ln h^i_{be}(t|x_i, z_{it}) = \gamma_0^{be}\, duration_{it} + \gamma_1^{be}\, age_{it} + \beta_0^{be} + \beta_1^{be} x_i + \beta_2^{be} z_{it},\ b, e = 1, 2, \ldots, 4,\ b \neq e$$

where the vector x_i includes person-specific variables such as gender while the vector z_{it} includes time-varying spell-specific variables such as health or marital status. As noted previously, a complete description of the variables included in the econometric analysis is provided in Table 3. Regression coefficients indicate each variable's effect on the hazard function or the probability of transition. A positive coefficient increases this probability and therefore decreases expected duration.

It is important to note that the hazard incorporates two different types of duration dependence: age and living-arrangement duration dependence. These two effects are separately identifiable because the duration clock is reset to zero after a transition whereas the age clock is not. Although living-arrangement decisions may be affected by policies which are likely to change over time (are calendar time dependent), identifying such time effects is limited by our small sample size (we do not observe enough transitions to differentiate its impact from the impact of age). It would also be possible to let the impact of age differ across transition types. However, estimation results do not reject the hypothesis that $\gamma_1^{be} = \gamma_1^b, \forall e$. As a result, henceforth we assume $\gamma_1^{be} = \gamma_1^b, \forall e$. Finally, we do not allow any nonlinearities in duration dependence due to our small sample size.

Then, if we observe a sick elderly individual i through C_i cycles (where $C_i = 2$ or 3), his or her contribution to the log likelihood will be

(4) $$L_i = \sum_{c=1}^{C_i} \sum_{b=1}^{3} \sum_{e=1}^{4} d_b^i [m_e^i \log h_{be}^i(t^i) - \Lambda_b(t^i)],$$

where the integrated hazard takes the familiar form

(5) $$\Lambda_b(t) = \int_0^t \sum_{b \neq e} h_{be}(t)\, dt;\ b, e = 1, 2, \ldots, 4\ \ b \neq e$$

and where the two sets of binary indicators are defined as follow

$$d_b = \begin{cases} 1 & \text{if } b \text{ is entered at the beginning of the cycle} \\ 0 & \text{otherwise} \end{cases}$$

$$m_e = \begin{cases} 1 & \text{if } e \text{ is entered at the beginning of the cycle} \\ 0 & \text{otherwise.} \end{cases}$$

For a censored observation, $d_e = 0$, $e = 1, \ldots, 4$. Hence its contribution to the likelihood is simply

(6) $$exp(-\Lambda_b(t)).$$

Note that some transition intensities may be identically zero (that is, for transitions out of an absorbing state). We next discuss two potential issues that must be addressed when estimating duration models of this type.

1. Initial Conditions

Many studies that use duration models suffer from what is known as an initial-conditions problem. The problem lies in the fact that individuals (and their choices) are not observed prior to the point when data collection began (that is, are not observed, prior to the first observation). As a result, the likelihood function must be conditioned on the initial state as well as the individual's state history prior to the first observation. However, because the data we use are based on a retrospective questionnaire in which dates were given for each parent's transition from one type of living arrangement to another from their time-of-illness until their death or until 1991, there is no initial conditions problem. In other words, in our data everyone begins in independent living.

2. Unobserved Heterogeneity

In order to account for potential unobserved heterogeneity, we assume that the hazard rate depends on a random person-specific effect θ_i (where θ_i can be interpreted as a person-specific taste for change or person-specific frailty) through transition-specific load factors λ^{be}.[19] Allowing the load factors to vary by transition types allows the scalar unobservable (θ) to play a living-arrangement spell-specific role. Also, the presence of individual-specific unobserved heterogeneity allows durations across different living-arrangement spells to be correlated at the individual level.[20] Thus, the unobservable component for spells of the type be is given by $\lambda^{be}\,\theta$ where the covariance between $\lambda^{be}\,\theta$ and $\lambda^{b'e'}\theta$ is $\lambda^{be}\,\lambda^{b'e'}$ assuming $E[\theta] = 0$ and $var\,(\theta) = 1$. As a result, in a model without covariates, living-arrangement spells would be negatively (positively) correlated if $\lambda^{be}\,\lambda^{b'e'}$ is negative (positive).

This allows us to rewrite the conditional hazard as:

$$\ln h^i_{be}(t \mid x_i, z_{it}) = \gamma_0^{be}\,duration_{it} + \gamma_1^{be}\,age_{it} + \beta_0^{be} + \beta_1^{be}\,x_i + \beta_2^{be}\,z_{it} + \lambda^{be}\theta_i, b, e = 1, 2, \ldots, 4, b \neq e. \quad (7)$$

Note that θ_i is independent of the values of any regressor. Identification of the load factors (λ^{be}) is achieved through the observation of the same individual across multiple types of living arrangements. The likelihood function is built in the same manner as before. Estimation is done by maximizing the marginal likelihood and integrating out the heterogeneity components θ_i:

$$L_i(\gamma, \beta, \lambda; duration_{it}, age_{it}, x_{it}, z_{it}) = \int_{-\infty}^{+\infty} \prod_{c=1}^{C_i} \mathrm{L}\,(\gamma, \beta, \lambda; duration_{it}, age_{it}, x_{it}, z_{it}, \theta_i) f(\theta_i)\, d\theta. \quad (8)$$

19. See Heckman and Walker (1990) who introduce unobserved heterogeneity in a similar way.

20. Note that imposing independence when it does not hold will result in inconsistent estimates of the coefficients.

We use Gauss-Hermite Quadrature to approximate the normal integral.

IV. Results

Results with respect to coefficients describing the living-arrangement dynamics are summarized in Tables 5 and 6. Tables 5 and 6 present estimates of the age-dependence γ_1^b parameters and the duration-dependence γ_0^{be} parameters, respectively. Parameter estimates for the load factors are presented in Table 7. Table 8, which is divided into three parts, presents coefficients for other covariates of interest for transitions out of independence, cohabitation and nursing home, respectively. Because results will be discussed conditional on a particular current living arrangement, they are not directly comparable with previous results which have focused on the unconditional likelihoods of being in a particular living arrangement. We do, however, compare our results with those of previous work in Subsection IVD. Because unobserved heterogeneity is found to be important (see Table 7), all tables include results without (Column "Base") and with (Column "Mixed") unobserved heterogeneity.[21,22] Finally, we note that the standard errors provided in the results tables are based on numerical second derivatives.

Table 5
Living Arrangement Dynamics I

	Age dependence (γ_1^b)—All States	
	Base	Mixed
Independent	0.23***	0.47***
	(0.01)	(0.04)
Cohabitation	0.02*	0.05
	(0.01)	(0.05)
Nursing home	0.03***	0.12***
	(0.01)	(0.04)

Note: Standard Errors in Parentheses.
[***] ** (*) indicates statistical significance at the [1 percent] 5 percent (10 percent) level.

21. With respect to our model's goodness-of-fit, we reject the "Base" model (where the load factors are set equal to zero) in favour of the "Mixed" model. The likelihood ratio test of the null hypothesis where all load factor are zero is: $LR = 2 * (7957.45 - 7847.07) = 220.88 > \chi_9^2 = 3.33$ at the 5% level. Similarly, we test for the importance of duration dependence. Specifically, we test the hypothesis that the nine duration-dependence parameters γ_0^{be} are zero with a likelihood ratio test and reject the simpler mode: $LR = 2(8155.93 - 7847.01) = 617.84 > \chi_9^2 = 3.33$.
22. For the purpose of estimation, we assume individuals become at risk of transiting into different living arrangements at 50 years of age. In fact, the first transition observed in our data set occurs at 51 years of age.

Table 6
Living Arrangement Dynamics II

	Duration dependence (γ_0^{be}) Independent		Cohabitation		Nursing Home		Death	
	Base	Mixed	Base	Mixed	Base	Mixed	Base	Mixed
Independent			–0.10***	– 0.14***	–0.08***	0.48***	–0.10***	–0.19***
			(0.00)	(0.03)	(0.01)	(0.08)	(0.00)	(0.01)
Cohabitation	–2.56**	–2.61**			0.04	0.01	0.07**	0.05
	(1.04)	(1.06)			(0.07)	(0.07)	(0.03)	(0.05)
Nursing home	–3.37***	–3.23***	–0.63*	–0.72**			0.00	–0.06*
	(1.08)	(1.05)	(0.36)	(0.35)			(0.02)	(0.04)

Note: Standard errors in parentheses.
[***] ** (*) indicates statistical significance at the [1 percent] 5 percent (10 percent) level.

Table 7
Load Factors—Mixed Model

	Parameter Estimates—Unobserved Heterogenetiy (λ^{be})			
	Independent	Cohabitation	Nursing Home	Death
Independent		2.32***	6.49***	1.38***
		(0.26)	(0.48)	(0.21)
Cohabitation	0.75		0.40	0.21
	(0.58)		(0.49)	(0.48)
Nursing home	1.41***	1.28***		0.59**
	(0.41)	(0.45)		(0.29)

Note: Standard Errors in Parentheses.
[***] ** (*) indicates statistical significance at the [1 percent] 5 percent (10 percent) level.

A. *Transitions out of Independence*

We first examine estimation results for elderly individuals whose current living arrangement is independent living. In the first row of Table 5, we find that growing older significantly and positively affects the risk of transiting out of independent living; the effect being considerably greater once we control for unobserved heterogeneity. This could be due to an unobservable worsening of the individual's health and functional abilities. Estimates for duration dependence (presented in Table 6) also increase in magnitude once unobserved heterogeneity has been accounted for. Our results suggest that duration dependence is negative for transitions into cohabitation but positive for transitions into nursing home. That is, controlling for age, health and demographic characteristics, individuals are more likely to transit into a nursing home, yet less likely to transit into cohabitation, as time spent in independent living increases.

Turning to the first part of Table 8, we find that being female increases the transition intensity associated with moving into a nursing home. This is not surprising given that women often outlive their spouse. Furthermore, it is possible that males are less able to care for their ailing spouses than are females (perhaps because of caregiving capital accumulation). Females also have a greater transition intensity associated with moving from an independent living arrangement to cohabitation. This result may reflect the relatively greater ability of females at providing "home-making" services to the family unit such as caring for grandchildren.

Estimates also suggest that having more children decreases the transition intensity associated with nursing home. This is likely because: (i) parents with many children have a greater probability of finding a child who is able and willing to provide care and assistance; and/or (ii) larger families are better able to share caregiving responsibilities by reducing the burden imposed on each caregiver. Furthermore, being married increases the transition intensity associated with moving from an independent

Table 8
Parameter Estimates-Markov Model

State of origin: Independent	Destination State					
	Nursing Home		Cohabitation		Death	
	Base	Mixed	Base	Mixed	Base	Mixed
Demographics						
Constant	–23.44***	–126.05***	–21.24***	–45.01***	–20.96***	–39.84***
	(0.74)	(9.14)	(0.63)	(3.93)	(0.63)	(3.04)
Mother	0.08	0.51*	0.16	0.34*	–0.30*	–0.21
	(0.15)	(0.29)	(0.16)	(0.18)	(0.16)	(0.17)
NumChild	–0.04	–0.25***	0.10***	0.03	0.01	–0.02
	(0.02)	(0.05)	(0.02)	(0.03)	(0.02)	(0.03)
Rural	0.15	1.53***	0.09	0.47***	–0.11	0.02
	(0.13)	(0.28)	(0.14)	(0.16)	(0.14)	(0.16)
Married	0.41***	1.82***	–0.26	–0.01	1.74***	2.19***
	(0.16)	(0.28)	(0.18)	(0.20)	(0.18)	(0.20)
Health						
Eating	–0.02	–0.99***	0.01	– 0.28	0.04	–0.05
	(0.15)	(0.29)	(0.18)	(0.21)	(0.17)	(0.19)
Walking	0.22	1.06***	– 0.28*	0.00	0.42***	0.52***
	(0.14)	(0.30)	(0.16)	(0.20)	(0.16)	(0.18)
Hearing	–0.70***	–3.38***	– 1.20***	–1.60***	–0.47***	–0.86***
	(0.14)	(0.34)	(0.16)	(0.20)	(0.15)	(0.18)
Seeing	–0.26*	–0.14	0.13	0.32**	–0.27*	–0.29*
	(0.14)	(0.25)	(0.14)	(0.16)	(0.15)	(0.17)
Think	0.46***	0.43	–0.12	–0.26*	–0.20	–0.29*
	(0.13)	(0.27)	(0.14)	(0.16)	(0.14)	(0.16)
Heart	–0.09	–0.53**	–0.22	– 0.29	0.36**	0.40**
	(0.16)	(0.25)	(0.17)	(0.19)	(0.16)	(0.17)
Angina	–0.35*	–1.31***	0.05	–0.24	0.02	–0.14
	(0.19)	(0.31)	(0.19)	(0.22)	(0.18)	(0.20)
Kidney	0.10	1.50***	0.00	0.30	0.70***	0.88***
	(0.23)	(0.35)	(0.23)	(0.26)	(0.20)	(0.22)
Contbow	0.23*	0.57**	0.12	0.12	–1.28***	–1.26***
	(0.14)	(0.23)	(0.16)	(0.18)	(0.24)	(0.25)
Stroke	0.39***	2.14***	–0.17	0.35*	–0.08	0.00
	(0.13)	(0.31)	(0.15)	(0.18)	(0.15)	(0.17)
N = 1,237	300		263		454	

Note: Standard errors in parentheses.
[***] ** (*) indicates statistical significance at the [1 percent] 5 percent (10 percent) level.

Table 8 (*continued*)

	Destination State					
	Nursing Home		Independent		Death	
State of origin: Cohabitation	Base	Mixed	Base	Mixed	Base	Mixed
Demographics						
Constant	–2.42**	–5.08	–1.66	–4.40	–3.30***	–5.87
	(1.03)	(4.16)	(1.27)	(4.22)	(0.98)	(4.15)
Mother	–1.01**	–0.92**	–1.07	–0.97	–0.89***	–0.88***
	(0.42)	(0.43)	(0.65)	(0.66)	(0.23)	(0.24)
NumChild	–0.05	–0.05	–0.35**	– 0.37**	0.03	0.03
	(0.07)	(0.07)	(0.17)	(0.18)	(0.04)	(0.04)
Rural	0.09	0.17	–0.45	–0.31	–0.17	–0.16
	(0.39)	(0.40)	(0.86)	(0.88)	(0.23)	(0.23)
Married	–1.54**	–1.49**	–0.35	–0.28	0.28	0.39
	(0.65)	(0.67)	(0.89)	(0.89)	(0.26)	(0.29)
Health						
Eating	–0.29	– 0.30	0.28	0.26	0.09	0.04
	(0.60)	(0.60)	(0.95)	(0.94)	(0.31)	(0.31)
Walking	0.05	0.09	0.54	0.67	0.41	0.47
	(0.53)	(0.53)	(0.80)	(0.82)	(0.31)	(0.33)
Hearing	–0.89*	–1.00*	–0.67	–0.77	0.11	–0.02
	(0.48)	(0.52)	(0.88)	(0.92)	(0.25)	(0.30)
Seeing	–0.75*	–0.73*	–1.49	–1.46	–0.24	–0.25
	(0.43)	(0.44)	(1.10)	(1.12)	(0.22)	(0.23)
Think	0.08	0.04	0.33	0.36	–0.08	–0.09
	(0.38)	(0.38)	(0.66)	(0.67)	(0.22)	(0.22)
Heart	–1.03*	–1.06*	–0.30	–0.36	0.50*	0.49*
	(0.56)	(0.56)	(0.97)	(0.98)	(0.27)	(0.28)
Angina	0.22	0.16	–0.08	–0.24	–0.22	–0.25
	(0.65)	(0.67)	(1.10)	(1.12)	(0.28)	(0.30)
Kidney	–1.85**	–1.87**	0.04	– 0.18	0.13	0.15
	(0.84)	(0.85)	(1.19)	(1.23)	(0.31)	(0.31)
Contbow	0.59	0.59	1.13	1.30	–0.49	–0.48
	(0.56)	(0.56)	(0.77)	(0.80)	(0.39)	(0.39)
Stroke	–0.28	– 0.22	†	†	0.04	0.08
	(0.43)	(0.44)	†	†	(0.24)	(0.25)
N = 261	11		37		110	

Note: Standard errors in parentheses.
[***] ** (*) indicates statistical significance at the [1 percent] 5 percent (10 percent) level.
† No variation in explanatory variable.

Table 8 (*continued*)

State of origin: Nursing Home	Destination State					
	Independent		Cohabitation		Death	
	Base	Mixed	Base	Mixed	Base	Mixed
Demographics						
Constant	–3.90***	–11.08***	– 6.81***	–13.97***	–3.83***	– 10.90***
	(1.32)	(3.35)	(1.38)	(3.40)	(0.85)	(3.21)
Mother	–0.73	–0.76	–0.15	0.04	–0.44**	– 0.39**
	(0.60)	(0.61)	(0.68)	(0.72)	(0.18)	(0.18)
NumChild	–0.35*	– 0.41**	0.23**	0.14	0.00	–0.03
	(0.18)	(0.20)	(0.12)	(0.12)	(0.04)	(0.04)
Rural	–0.42	–0.19	0.24	0.38	–0.09	0.03
	(0.68)	(0.69)	(0.66)	(0.66)	(0.17)	(0.18)
Married	1.11*	1.00	–1.50	–1.59	–0.04	0.13
	(0.62)	(0.64)	(1.10)	(1.13)	(0.18)	(0.19)
Health						
Eating	–0.07	–0.60	–0.22	–0.31	0.51**	0.45**
	(0.75)	(0.77)	(0.83)	(0.91)	(0.21)	(0.21)
Walking	–0.18	0.12	0.64	0.80	–0.03	0.08
	(0.69)	(0.70)	(0.79)	(0.87)	(0.19)	(0.20)
Hearing	–0.60	–0.96	1.00	0.84	–0.32*	–0.55***
	(0.68)	(0.72)	(0.69)	(0.70)	(0.18)	(0.21)
Seeing	0.40	0.49	–2.48**	–2.36*	–0.16	–0.18
	(0.60)	(0.63)	(1.19)	(1.21)	(0.17)	(0.18)
Think	0.85	0.97	–0.55	–0.25	–0.02	0.00
	(0.66)	(0.66)	(0.71)	(0.72)	(0.16)	(0.17)
Heart	0.75	0.43	–0.70	–1.10	0.43**	0.35*
	(0.69)	(0.70)	(0.77)	(0.79)	(0.17)	(0.18)
Angina	0.29	0.50	1.51*	1.67**	0.02	0.03
	(0.73)	(0.76)	(0.79)	(0.83)	(0.21)	(0.22)
Kidney	–0.56	–0.40	–0.30	–0.06	0.54**	0.59**
	(1.13)	(1.15)	(1.18)	(1.23)	(0.25)	(0.25)
Contbow	0.60	0.56	0.97	0.94	–0.70**	–0.83**
	(0.67)	(0.68)	(0.87)	(0.88)	(0.32)	(0.33)
Stroke	–0.33	– 0.12	0.41	0.53	0.40**	0.59***
	(0.61)	(0.62)	(0.68)	(0.69)	(0.16)	(0.19)
N = 316	13		12		184	

Log-likelihood (base model) = –7,957.45
Log-likelihood (mixed model) = –7,847.01
Note: Standard errors in parentheses.
[***] ** (*) indicates statistical significance at the [1 percent] 5 percent (10 percent) level.

living arrangement into a nursing home. Although this may seem surprising at first, it is important to note that this does not necessarily imply that individuals are more likely to end up in a nursing home if they are married. This is because transitions into nursing homes can come from both independent living and cohabitation. Thus, it is possible (and in fact, appears to be the case given our results), that married individuals are more likely to transit from independent living to nursing home but less likely to transit from cohabitation into nursing home. Consequently, married individuals could be unconditionally less likely to reside in a nursing home while being conditionally more likely to transit from independent living to nursing home.

Examining the coefficients for health indicators, we notice that having difficulties with walking or controlling bowels, having kidney problems, having problems thinking, concentrating and with memory or having experienced a stroke increases the transition intensity associated with a move from an independent living arrangement into a nursing home.[23] Our results are consistent with those in the literature which often find that health problems and functional disabilities increase the likelihood of living in a nursing home. However, having difficulties eating or hearing, or suffering from heart disease or angina decreases the same transition intensity. Although serious, these later types of difficulties and illnesses may be more easily cared for in a home setting than those found to increase the transition intensity from independent to nursing home.

B. Transitions out of Cohabitation

With respect to elderly parents in need of care who currently cohabit, we find no positive age duration once we control for unobserved individual heterogeneity. However, results from Table 6 suggest a rather different dynamic for transitions out of cohabitation than for transitions out of independent living. In fact, our results suggest that individuals are much less likely to return to independent living as the length of their cohabiting stay increases. This result suggests that independent living is a very unlikely exit route for individuals who cohabit, especially as time goes by. This negative duration dependence may reflect a parent's growing dependence on informal family care or the increased fixed costs associated with returning to independent living (for example, as time goes by, it is more likely that the parent's home and other personal items will have been sold). We find no significant duration dependence, however, with respect to transitions out of cohabitation into nursing home.

We also find in Table 8 that sick elderly mothers who cohabit (relative to sick elderly fathers who cohabit) are less at risk of transiting into nursing-home care and less at risk of dying (the transition intensity from cohabitation into independent living is not statistically different for men and women). Thus, estimates indicate that durations in cohabitation are likely to be longer for women than for men. Part of the reason that cohabiting stays may be more stable for mothers than for fathers may be their ability in providing home-making services such as caring for grandchildren.

23. Although the PHS contains other health and disability variables, we chose those which were most likely to affect individuals' ability to take care of themselves without assistance while also not suffering from many missing values.

Results also indicate that having more children decreases the cohabitation-into-independent-living transition intensity. This result likely reflects the ability of larger families to care for their sick elderly parents in a shared living arrangement. Being married appears to reduce the transition intensity from cohabitation into nursing home (which is markedly different from our finding that married individuals are more likely to transit from independent living to nursing home). This suggests that spouses may be complimentary caregivers during cohabitation. Results also indicate that suffering from heart or kidney disease or having problems seeing decreases the transition intensity associated with moving from cohabitation into a nursing home.

C. Transitions out of Nursing Homes

Results indicate that elderly parents in need of care are more likely to transit out of nursing home as they grow older. Furthermore, transitions out of nursing homes exhibit negative duration dependence for both transitions to independent living and cohabitation. Moreover, duration dependence for reentry into independent living is also greater for individuals in nursing homes relative to cohabitation. That is, individuals are less likely to transit from nursing home to both independent living and cohabitation as time spent in nursing home increases. These two results are consistent with financial and psychic costs associated with reentry into independent living or cohabitation; costs which are likely to increase as time spent in a nursing home goes by.

Table 8 shows that being married increases the likelihood of transiting from a nursing home care back into independent living. Furthermore, elderly individuals are less likely to return to independent living but more likely to transit into cohabitation, as the number of children increases. These results again underscore the importance of informal caregivers as potential substitutes to nursing home care. Turning to health indicators, we find that having problems seeing decreases the risk of transiting into cohabitation (from nursing home) while having angina increases the same transition intensity.

D. Comparing results with the previous literature

Given our results presented in the previous sections, we can now compare several of them with those from the literature. For example, consider the role of gender on the likelihood of living in a nursing home. Recall that the literature consistently finds that males are more likely to be institutionalized than women. Our results suggest that men are less likely to transit from independent to nursing home and to cohabitation but are much more likely to transit from cohabitation to nursing home. Thus, the greater unconditional likelihood of living in a nursing home for men may be driven partly by the lack, or instability, of cohabitation as a living-arrangement choice for men.

Similarly, the literature consistently finds that being married reduces the likely of living in a nursing home. Our results suggest that married individuals are more likely to transit from independent to nursing home, but that married individuals are less likely to transit from cohabitation to nursing home. Thus, it appears that the effect of marital status on the unconditional likelihood of living in a nursing home is very different from the conditional likelihood of transiting from a particular living arrangement to nursing home.

Our results are consistent with the previous literature which suggests that having more children decreases the likelihood of living in a nursing home and increases the likelihood of cohabiting. We find that having more children decreases the likelihood of transiting from independent to nursing home, increases the likelihood of leaving nursing home care cohabitation, and decreases the likelihood of leaving cohabitation to go back to independent living. Thus, it appears that children serve as important substitutes to formal nursing-home care.

Finally, our results are consistent with much of the past literature which has found that both illness and functional disabilities contribute to an individual's likelihood of living in a nursing home.

V. Conclusion

In this paper, we examine the living-arrangement dynamics of elderly individuals in need of care in a dynamic setting. Because elderly individuals often experience more than one type of living arrangement and that current living arrangements (as well as their lengths) likely influence future ones, we estimate a model which takes into account such dynamic features. More specifically, we estimate a simultaneous random-effects competing-risks model which also controls for unobserved heterogeneity.

By using the full living-arrangement history of elderly parents in need of care, we find that age and duration dependence are important predictors of living-arrangement transitions. We also find that the roles of many covariates are transition specific. Our results suggest, for example, that being female, having fewer children, being married, having problems thinking, and having suffered a stroke all increase the transition intensity associated with moving from independent living to nursing home. On the other hand, we find that being female and being married each decrease the transition intensity associated with moving from cohabitation to nursing home. These results, suggest that policies which seek to affect the living-arrangement decisions of elderly individuals in need of care may be more effective if they are targeted towards certain individuals. For example, policies which seek to reduce institutionalization may be more effective if they are targeted to "at risk" individuals, where the "at risk" population may differ from one living arrangement to another. More specifically, our results suggest that policies may be more effective at reducing institutionalization if, among those living independently, they are targeted at married females with fewer children while, among those who cohabit, they are targeted at single fathers. They may also be more effective at encouraging individuals to return to community-based living arrangements if, among those who are living in a nursing home, they are targeted towards those in the early stages of the living arrangement. More research, however, is necessary in order to determine why certain individuals are more "at risk" of transiting in or out of nursing-home care and, consequently, which policies should be applied in order to reduce institutionalization.

Overall, our approach and results present a more complex picture of the living-arrangement decisions of sick elderly individuals than previous work based primarily on cross-sectional analysis. Furthermore, applying the same methodology to longitudinal data on aging would be interesting once these panels contain enough years to build the full living arrangement histories. Although we focus on sick elderly individuals with children (an important sub-population from a policy perspective), more complete data would allow us to broaden our analysis to the general elderly population.

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