Dynamics of Long-Term Care Family Decision Making

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February 24, 2011

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1 Introduction

In light of population aging and high disability rates among the elderly (Butler, 1997; Spillman and Murtaugh, 2005), many families face decisions concerning long-term care arrangements for disabled elderly relatives. With the assistance of family members, most notably spouses and adult children, many disabled elderly individuals remain in the community (Shirey and Summer, 2000). Others rely exclusively on formal home health care or a combination of formal home health care and informal care provided by relatives and friends (Mack and Thompson, 2005). Institutional care represents the other major source of care for this population (Burwell and Jackson, 1994).

Long-term care arrangements have profound economic, social, and psychological implications. Estimates suggest that national spending on long-term care for the elderly and the disabled exceeded $200 billion in the year 2005 (Komisar and Thompson, 2007). Medicaid and Medicare respectively covered approximately 49 and 20 percent of these expenses, while private health and long-term care insurance covered roughly 7 percent. Individuals and their families financed about 18 percent of long-term care services that year, while the remaining 5 percent was financed by other private and public sources (Komisar and Thompson, 2007). Most informal care provided by family members is unpaid, but the opportunity costs in terms of foregone earnings, household production, and leisure are often substantial. Moreover, the provision of informal care can be psychologically burdensome for caregivers (Martin, 2000; Byrne, Goeree, Hiedemann and Stern, 2009), and institutional care often entails high social and psychological costs for elderly individuals (Macken, 1986).

The aging of the population and the profound implications of care arrangements for elderly individuals, their families, and society highlight the importance of developing appropriate public policies concerning long-term care arrangements for the elderly. Although an extensive literature examines long-term care arrangements for the elderly, most studies neglect the intertemporal dimensions of care.[2] We contribute to the long-term care literature by developing and estimating three dynamic models of families' care arrangements. These models distinguish among care provided by a spouse, care provided by an adult child or child-in-law, formal home health care, and institutional care, while also allowing for the

[2] As discussed later, exceptions include Garber and MaCurdy (1990), Boersch-Supan, Kotlikoff, and Morris (1991), Dostie and Léger (2005), Heitmueller and Michaud (2006), and Gardner and Gilleskie (2009); however, some of these studies focus on living arrangements rather than care arrangements.

possibility that the elderly individual remains independent. With data from five waves of the Assets and Health Dynamics Among the Oldest Old Survey collected between 1995 and 2004, we estimate several models of families' long-term care arrangements for the elderly. These models capture several dimensions of families' care arrangements, namely the use of each potential care arrangement, the selection of the primary care arrangement, and hours in each potential care arrangement. Our dynamic framework links care arrangements over time by allowing for state dependence (i.e., persistence in care arrangements), while distinguishing between spurious state dependence due to observed and unobserved heterogeneity and true state dependence (i.e., inertia). For example, our models distinguish between persistence in care arrangements attributable to a family's preferences (e.g., an aversion to institutional care) and inertia stemming from the high costs of transitioning from one care arrangement to another (e.g., into or out of institutional care). Our results suggest that inertia contributes to persistence in long-term care arrangements and thus highlight the importance of a framework that links care arrangements over time.

2 Literature Review

2.1 Formal Economic Models

Although predominantly empirical, the literature on long-term care arrangements for the elderly offers several formal economic models. Given the complexities inherent in families' long-term decisions, none of these models captures all dimensions of decision making within families. Most notably, these models vary with respect to the assumptions concerning preferences of family members, the number of children participating in the decision-making process, and the scope of care decisions considered.

Allowing for the possibility that preferences vary across family members, several papers present game-theoretic models (Sloan, Picone and Hoerger, 1997; Hiedemann and Stern, 1999; Pezzin and Schone, 1999a; Checkovich and Stern, 2002; Engers and Stern, 2002; Brown, 2006; Pezzin, Pollak and Schone, 2007; Byrne, Goeree, Hiedemann and Stern, 2009). Other models are based on the assumption of common preferences; for example, Hoerger, Picone, and Sloan (1996) and Stabile, Laporte, and Coyte (2006) rely on the assumption of a single family utility function. In Kotlikoff and Morris (1990), parent and child solve separate maximization problems if they live separately but maximize a weighted average of their individual utility functions subject to their pooled budget constraint if they live together.

In contrast to our previous work (e.g., Hiedemann and Stern, 1999; Engers and Stern, 2002; Byrne, Goeree, Hiedemann and Stern, 2009), this paper abstracts from the possibility that family members have different preferences concerning care arrangements in order to focus on the dynamic dimension of care.

Several models accommodate all adult children in the decision-making process (Hiedemann and Stern, 1999; Checkovich and Stern, 2002; Engers and Stern, 2002; Van Houtven and Norton, 2004; Brown, 2006; Byrne, Goeree, Hiedemann and Stern, 2009). Others simplify modeling and/or estimation by focusing on families that include only one child (Kotlikoff and Morris, 1990) or two adult children (Pezzin, Pollak and Schone, 2007) or by assuming that only one child participates in the family's long-term care decisions (Sloan, Picone and Hoerger, 1997; Pezzin and Schone, 1999a). In this paper, we restrict our sample to families with at most four children but we treat each child as a potential caregiver.

The models in this literature also vary with respect to the scope of care decisions examined. Models presented in Hiedemann and Stern (1999) and Engers and Stern (2002) focus on the family's selection of the primary care arrangement including informal care provided by an adult child, institutional care, or continued independence. Checkovich and Stern (2002) and Brown (2006) model the quantity of informal care provided by each adult child. Similarly, Sloan, Picone, and Hoerger (1997), Pezzin and Schone (1999a), Stabile, Laporte, and Coyte (2006), and Byrne, Goeree, Hiedemann and Stern (2009) model the provision of informal care and formal home health care. Stabile, Laporte, and Coyte's (2006) model distinguishes between publicly and privately financed home health care. Van Houtven and Norton (2004) model children's provision of informal care and parent's use of formal care, defined broadly as nursing home care, home health care, hospital care, physician visits, and outpatient surgery. Hoerger, Picone, and Sloan (1996) and Pezzin, Pollak, and Schone (2007) focus on living arrangements of the sick or disabled elderly (e.g., independent living in the community, residence in an intergenerational household, or residence in a nursing home). Distinguishing among care provided by a spouse, care provided by an adult child or child-in-law, formal home health care, and institutional care, this paper examines three dimensions of care – the use of each potential mode of care, the selection of the primary care arrangement, and hours in each arrangement.

2.2 Intertemporal Dimensions of Care

Although the provision of care for the elderly is an inherently dynamic process, most of the literature abstracts from the intertemporal dimensions of care. Exceptions include the work of Börsch-Supan, Kotlikoff, and Morris (1988), Garber and MaCurdy (1990), Dostie and Léger (2005), Heitmueller and Michaud (2006), and Gardner and Gilleskie (2009). Using a framework that accounts for unobserved heterogeneity and state dependence, Heitmueller and Michaud (2006) explore the causal links between employment and informal care of sick, disabled, or elderly individuals over time. As part of a dynamic model of savings and Medicaid enrollment decisions, Gardner and Gilleskie (2009) estimate long-term care arrangements jointly with savings and gifting behavior, health insurance coverage, and health transitions. Their approach incorporates unobserved permanent as well as time-varying heterogeneity.

The other three studies focus on living arrangements of the elderly. Börsch-Supan, Kotlikoff, and Morris (1988) examine transitions among living independently, living with adult children, and living in an institution. Garber and MaCurdy (1990) model transitions from living in the community to residing in a nursing home and vice versa as well as transitions from one of these two living arrangements to death. In a framework that accounts for unobserved heterogeneity as well as state and duration dependence, Dostie and Léger (2005) examine transitions among independent living, cohabitation, nursing home residence, and death.

Following Dostie and Léger (2005), Heitmueller and Michaud (2006), and Gardner and Gilleskie (2009), our dynamic framework accounts for unobserved heterogeneity and state dependence. Distinguishing among care provided by a spouse, care provided by an adult child or child-in-law, formal home health care, and institutional care, our models encompass a broader range of care arrangements than existing dynamic models. Examining three dimensions of care – the use of each potential mode of care, the selection of the primary care arrangement, and hours in each arrangement – our paper also presents a richer description of long-term care dynamics.

3 Data

To examine families' care arrangements over time, we use data from the 1995, 1998, 2000, 2002, and 2004 waves of the Assets and Health Dynamics Among the Oldest Old (AHEAD) survey. With an emphasis on the joint dynamics of health and demographic characteristics this nationally representative longitudinal survey provides a particularly rich source of information concerning long-term care arrangements for the elderly. Selection criteria for the initial AHEAD survey, conducted in 1993, include age and living arrangements. In particular, this initial wave contains 6047 households with non-institutionalized individuals aged 70 years or older. However, subsequent waves retain all living respondents, thus enabling the study of elderly individuals in the community as well as nursing home residents. Also, spouses of respondents are also respondents even if they would not otherwise qualify on the basis of their own age, thus increasing the sample size for the initial wave to 8222 respondents. Although AHEAD oversamples Florida residents, this oversampling introduces no estimation bias assuming that residential location is exogenous. AHEAD also oversamples black and Hispanic households.

After excluding observations with missing values for variables used in our analysis, individuals who participated in only one wave of the survey, individuals who provided inconsistent responses, individuals who married or remarried over the course of the survey, families with more than four children, and mixed-race couples, our sample consists of 3353 individuals including spouses of original respondents. In addition to 914 married couples (where each individual represents a respondent), the sample includes 267 unmarried men and 1258 unmarried women. The preponderance of women (nearly two thirds of the sample) and the higher marriage rates among men (77.4 percent of men compared to 42.1 percent of women) reflect differences in life expectancy by gender and age differences between husbands and wives. Collectively, these 2439 households report 4489 adult children and 3318 children-in-law. Over half (53.0 percent) of the elderly households participated in all five waves of the survey used in our analysis.

Our models include characteristics that influence an elderly individual's caregiving needs, opportunities, and preferences. The need for care may increase with age and activity limitations; accordingly, our models control for the elderly individual's age and the number of problems she experiences with activities of daily living (ADLs) and with instrumental activities of daily living (IADLs). The presence of a spouse may reduce an elderly individual's need for assistance from adult children or formal care providers, particularly if the spouse is relatively young and healthy; thus, our models control for the elderly individual's marital status, the spouse's age, and the numbers of ADL and IADL problems experienced by the spouse. Since patterns of care vary by the gender and race/ethnicity of the elderly individual (see Goeree, Hiedemann, and Stern, 2010), our models control for gender as well as race and ethnicity. Moreover, to capture potential differences in the role of gender by race and ethnicity (see Goeree, Hiedemann, and Stern, 2010), our models also include interactions between gender and race/ethnicity. Finally, the ability to purchase care may reduce an individual's dependence on relatives. In the absence of good asset and income data (**clarify problems with data and cite source**), our models include the elderly individual's educational attainment as a proxy for her financial resources.

Table 1 displays descriptive statistics for the respondents for the first year of data.[3] As a consequence of the exclusion of nursing home residents from the initial wave and the inclusion of spouses regardless of age, the characteristics of our sample differ from those of a random sample of individuals aged 72 years and over.[4] Respondents range from 49 to 103 years with a mean of 78 years and a standard deviation of 6 years. On average, the respondents report difficulty with less than one (0.54) activity of daily living (ADL) such as eating, dressing, or bathing, but the sample displays considerable variation with regard to ADL problems; while some individuals report no problems with activities of daily living, others report problems with as many as six ADLs. Similarly, the respondents report an average of less than one (0.43) problem with instrumental activities of daily living (IADLs), such as using a telephone, taking medication, handling money, shopping, or preparing meals; here too the sample displays considerable variation, with respondents reporting a range of zero to five IADL problems. In addition to 2906 individuals (86.7 percent of the sample) who identify as non-Hispanic white, the sample includes 324 individuals (9.7 percent of the sample) who identify as non-Hispanic black and 123 individuals (3.7 percent of the sample) who identify as Hispanic. Although the original sample includes individuals with other racial and ethnic identities, none of these individuals remained in our sample after applying the sample selection criteria described above. Nearly one third (33.2 percent) of respondents have a high school diploma but not a college degree, and 31.0 percent report a college or graduate degree.

[3] For most respondents, the first year of data used in our analysis is 1995; for others, it is later.

[4] The AHEAD data surveys respondents aged 70 or older in the first wave from 1993. Our data starts from the second wave in 1995, hence our individuals are aged 72 or older.

Variable	Mean	Std Dev	Min	Max
Characteristics of Elderly Individuals (N=3353)				
Female	0.65	0.48	0	1
Black	0.10	0.30	0	1
Hispanic	0.04	0.19	0	1
Age	77.96	6.03	49	103
Married	0.55	0.50	0	1
Spouse's Age	41.63	38.26		
High School Diploma	0.33	0.47	0	1
College Degree	0.31	0.46	0	1
Spouse: High School Diploma	0.19	0.39		
Spouse: College Degree	0.19	0.39		
# ADL Problems	0.54	1.25	0	6
# IADL Problems	0.43	1.06	0	5
Spouse: # ADL Problems	0.25	0.89	0	6
Spouse: # IADL Problems	0.20	0.77	0	5
Characteristics of Adult Children and Children-in-Law (N=7807)				
Female	0.51	0.50	0	1
Age	48.86	8.42	14	89
Married	0.85	0.36	0	1
Number of Children	2.18	1.57	0	13
Years of Education	13.94	2.36	0	18
Weekly Hours of Work	29.77	16.33	0	40
Resides within 10 Miles of Parent	0.36	0.48	0	1
Resides with Parent	0.03	0.18	0	1
Market Conditions (N=2439)				
Home Health Care Per Week ($100)	872	73	699	1081
Ln (Nursing Home Beds Per Individual Above 70 Years)	-2.85	0.38	-3.64	-2.27
Average ADL Score	5.81	0.31	5.20	6.70
Nursing Home Staff Hours Per Resident Per Day	3.06	0.23	2.40	3.60
Medicaid Policies Facing Households in Our Sample in 1993				
Medically Needy Program (N = 2439)	0.96	0.20	0	1
Income Limit Facing Individuals (N = 1525)	446	79	238	724
Income Limit Facing Couples (N = 914)	673	160	311	1110

Table 1: Descriptive Statistics for the First Year

As mentioned earlier, the elderly households in our sample report a total of 4489 adult children and 3318 children-in-law. Since each member of this generation is a potential caregiver, our models also include demographic characteristics of the adult children and children-in-law. These characteristics reflect a potential caregiver's opportunity costs of time, effectiveness in the caregiving role, and/or burden associated with caregiving. Specifically, the models control for the adult child's or child-in-law's years of schooling, work status, marital status, family size (number of children), age, and proximity to her elderly parent(s) or parent(s)-in-law. Given evidence that daughters are significantly more likely than sons to provide care for elderly parents, even after controlling for relevant characteristics (e.g., Sloan, Picone and Hoerger, 1997; Wolf, Freedman and Soldo, 1997; Checkovich and Stern, 2002; Engers and Stern, 2002; Koh and MacDonald, 2006), our models also distinguish between sons and daughters. Moreover, as discussed extensively in Goeree, Hiedemann, and Stern (2010), the role of child gender in elder care provision may vary by race and ethnicity; thus, the model also interacts the adult child's gender with his/her race/ethnicity.

The second panel of Table 1 displays descriptive statistics for the 7807 children and children-in-law for the first year of data. This generation displays near gender balance: 51.1 percent are daughters or daughters-in-law. The average child or child-in-law is 48.9 years old with 13.9 years of schooling. These individuals report 29.8 hours of labor market work per week, but this figure probably understates mean labor market activity, because weekly work hours are truncated at 40.0. On average, the adult children and children-in-law of the elderly respondents have 2.2 children, but it is worth noting that some of these children belong to both a child and a child-in-law. A small proportion (3.3 percent) of the adult children and children-in-law reside with the elderly respondents, and over one third of this middle generation (35.5 percent) lives within 10 miles of the elderly respondents.

In addition to demographic characteristics and activity limitations, market conditions and public policies may influence families' care arrangements for elderly individuals. Our models control for several dimensions of the market for formal care in the elderly individual's or couple's state of residence: the average weekly cost of full-time home health care (16 hours a day for seven days or 112 hours per week), nursing home staff hours per nursing home resident per day in facilities with Medicare or Medicaid beds, nursing home beds per individual above 70 years, and the overall level of disability among nursing home residents. The overall disability level among nursing home residents is measured using a composite score that reflects nursing home residents' needs for assistance with three activities of daily living, namely eating, toileting, and transferring. Each nursing home resident was assigned a score from one to three for each of these three ADLs. A score of one implies that the individual needs little to no assistance with that ADL while a score of three implies that she needs substantial assistance with that ADL. Thus, a summary case mix score ranging from three to nine was compiled for each facility; individual facility scores were then summarized for each state.

The market for formal home health care and institutional care varies by state. The statistics presented in the third panel describe the market conditions facing elderly households in our sample during the first year of data. On average, these households reside in states where the mean weekly cost of full-time home health care is $872. Ranging from $699 to $1081, these are real costs, deflated with state-specific price deflators. The elderly households in our sample live in states with 2.4 to 3.6 nursing home staff hours per nursing home resident per day and 2.6 ($100 * \exp(-3.637)$) to 10.3 nursing home beds per 100 individuals over 70 years. On average, the households in our sample reside in states where the mean facility score is 5.8 with a standard deviation of 0.31 and a range from 5.2 to 6.7.

Many households rely on public assistance, most notably Medicaid, to cover their long-term care expenses. Eligibility for Medicaid is linked to actual or potential receipt of cash assistance under the Supplemental Security Income (SSI) program or the former Aid to Families with Dependent Children (AFDC) program. Elderly individuals or couples are eligible for SSI payments if their monthly countable income (income less $20) and countable resources fall below a certain threshold. Income limits for Medicaid eligibility vary widely by state;[5] given the lack of state-level data for some of the subsequent years and the high correlation of a state's income limits across time, our models include 1993 income limits. In most states, individuals or couples whose incomes exceed the limits for Medicaid eligibility qualify for assistance if their medical expenses are high relative to their incomes. In the presence of a medically needy program, households can deduct medical expenses from income when determining eligibility for Medicaid coverage of nursing home care. Thus, our models also control for the presence of a medically needy program.

The lowest panel of Table 1 presents the average Medicaid income limits facing elderly individuals and couples in our sample as well as the proportion of sampled households residing in states with a medically needy program; again these statistics reflect policies in effect in 1993. Individuals face monthly income limits ranging from $238 to $724 with a mean of $446; couples face monthly income limits ranging from $311 to $1110 with a mean of $673. Over 95.0 percent of our sampled households reside in states that had a medically needy program in 1993.

As discussed in more detail later, we present three different dynamic models of families' long-term care decisions. In particular, we model the family's decision whether to use each potential care arrangement, the family's selection of the primary care arrangement, and hours spent in each care arrangement in each period. Our models distinguish among several modes

[5] (see http://people.virginia.edu/~sns5r/resint/ltcstf/medicaideligibility.pdf)

of care – institutional care, formal home health care, informal care provided by a spouse, and informal care provided by a child or child-in-law – while allowing for the possibility that an elderly individual does not receive any of these modes of care.

Most (91.0 percent) of the elderly individuals in our sample receive no care during the first year. Among those relying on at least one mode of care, informal care arrangements are more common than formal care arrangements. More specifically, as shown in Table 2, 6.7 percent of respondents receive care from a spouse and 3.2 percent receive care from an adult child or child-in-law. While 1.3 percent of respondents rely on formal home health care, only 0.1 percent receives nursing home care. Similarly, during the first year of data, the spouse is the primary caregiver for 6.7 percent of the elderly individuals in our sample or for 74.4 percent of those reporting at least one form of care, an adult child or child-in-law is the primary caregiver for 1.5 percent of respondents or for 16.6 percent of those reporting at least one form of care, formal home health care is the primary care arrangement for 0.7 percent of respondents or for 8.0 percent of those reporting at least one form of care, and institutional care is the primary arrangement for 0.1 percent of the respondents and 1.0 percent of those reporting at least one form of care.

Not surprisingly, institutionalized elderly individuals receive more care than do elderly care recipients who remain in the community. As shown in Table 2, the average nursing home resident receives 93 hours of care per week in the first year of data. Also, as expected, spousal caregivers tend to provide substantially more care than do formal home health care providers or adult children. On average, during the first year of data, spousal caregivers provide an average of 56 hours of care per week. In contrast, the average amount of formal home health care is 13 hours per week among those who rely on this mode of care. The comparable figure for care provided by adult children or children-in-law is seven hours per week.

Mode of Care	Informal Care By Spouse	Informal Care By Child or Child-in-Law	Formal Home Health Care	Institutional Care
Any of this Mode (All Respondents)	6.7%	3.2%	1.3%	0.1%
Primary Arrangement (All Respondents)	6.7%	1.5%	0.7%	0.1%
Primary Arrangement (Care Recipients Only)	74.7%	16.6%	8.0%	1.0%
Mean Weekly Hours (Recipients of this Mode of Care)	56	7	13	93

Table 2: Frequency of Care Mode

As discussed earlier, we observe each elderly individual in our sample for at least two and at most five different time periods. As shown in Table 3, corresponding to 73,816 possible transitions into and out of each potential care arrangement, namely institutional care, formal home health care, informal care provided by a spouse, and informal care provided by a particular child or child-in-law, we observe 80 transitions into and seven transitions out of institutional care, 101 transitions into and 68 transitions out of formal home health care, 401 transitions into and 254 transitions out of spousal care, and 362 transitions into and 146 transitions out of informal care provided by a particular child or child-in-law.

	Persistence in Care Arrangements Across		Transitions Into and Out of Care	
Arrangement	Used Neither Period	Used Both Periods	Not Used/Used	Used/Not Used
Spouse	8283	289	401	254
Child or Child-in-Law	45430	197	362	146
Formal Home Health Care	9025	33	101	68
Nursing Home	9120	20	80	7

Table 3: Intertemporal Patterns of Care

4 Dynamic Models of Long-Term Care Arrangements

We model three related dimensions of families' care arrangements for an elderly individual in a particular time period: the use of each potential care arrangement, the selection of the primary care arrangement, and hours spent in each care arrangement. Our models distinguish among several modes of care, namely institutional care, formal home health care, informal care provided by a spouse, and informal care provided by an adult child or child-in-law. Our models also allow for the possibility that the elderly individual receives no formal or informal care in a particular period. In each model, the family makes decisions taking into account characteristics of the potential care arrangements.

In contrast to our previous work (e.g., Hiedemann and Stern, 1999; Engers and Stern, 2002; Byrne, Goeree, Hiedemann and Stern, 2009), here we abstract from the possibility that family members have different preferences concerning care arrangements in order to focus on the intertemporal dimensions of care. An elderly individual's care arrangements may evolve over time as her health improves or deteriorates, the health of her primary caregiver changes, her spouse dies, or formal home health care or institutional care becomes more or less expensive. In addition, adult children may rotate the role of primary caregiver as a way to share the burden or as the caregiver experiences burnout. Alternatively, care arrangements may remain stable over time as a result of the family's or elderly individual's preferences concerning care arrangements. Similarly, differences across family members with respect to their effectiveness in the caregiving role, opportunity costs of time, or burden associated with caregiving may contribute to persistence in care arrangements. Moreover, recent care arrangements may influence the current value of potential care arrangements. For example, the costs of transitioning from one care arrangement to another may enhance the value of the current arrangement, leading to persistence of a particular care arrangement over time; we call this type of persistence inertia.

We develop and estimate three dynamic models of care. Two of these are discrete choice models, while the third is a continuous choice model. In the Multiple Caregiver Model, the family decides whether to use each potential care arrangement (institutional care, formal home health care, care provided by the spouse, and care provided by each particular child); as its name implies, this model allows for the possibility that the elderly individual relies on more than one caregiver or caregiving arrangement. In the Primary Caregiver Model, the family selects the primary care arrangement from all available alternatives. Finally, in the Hours of Care Model, the family determines hours in each potential care arrangement. Like the Multiple Caregiver Model, this model allows for the possibility of multiple care arrangements.

In all of our models, we assume that each family has an underlying latent value for each potential care arrangement. More formally, consider a family that consists of one or two elderly individuals, J_n adult children, and up to J_n children-in-law. Elderly individual i may require care at time t. If she is married, her spouse may provide some or all of her care. In addition, each adult child or adult child-in-law is a potential caregiver. Depending on the model, the family decides whether to rely on each potential care arrangement, selects the primary care arrangement, or determines how much of each arrangement to use. Define the $J_n + 4$ caregiving alternatives for helping the elderly individual as: no help when the elderly individual does not receive formal or informal care ($j = 0$), care provided by a spouse ($j = -1$), formal home health care ($j = -2$), care in a nursing home ($j = -3$), and informal care from each of the J_n children or their spouses ($j = 1, 2, .., J_n$).

Let y^*_{nijt} denote the latent value of care alternative j to individual i in family n at time $t = 1, 2, ..., T$, which is given by[6]

$$y^*_{nijt} = X_{nit}\beta_j + Z_{njt}\gamma + \alpha_j y_{nijt-1} + \omega_{nijt}. \tag{1}$$

[6] The latent value in the continuous model will be augmented slightly to incorporate substitution across types of care.

The vector X_{nit} includes exogenous characteristics of the elderly individual. In particular X_{nit} includes demographic characteristics and activity limitations that may influence an elderly individual's caregiving needs, opportunities, and preferences. The vector Z_{njt} includes characteristics of the potential care arrangements, namely demographic characteristics of the adult children and children-in-law as well as market conditions and public policies in the elderly individual's or household's state of residence. Z_{njt} also includes interactions between the potential care recipient and the potential caregiver or care arrangement.

The observed variable corresponding to the latent variable is given by y_{nijt}. As discussed in the following subsections, the exact definition of the corresponding observed variable varies with the model specification. The inclusion of y_{nijt-1} allows past choices to influence the current value of alternative j and, as such, captures the true dynamic component of long-term care decision making. To distinguish between true state dependence or inertia (as captured by the α_j) and persistence in care arrangements due to unobserved heterogeneity (i.e., spurious state dependence), we allow for unobserved correlation across time (as captured by the ω_{nijt}). For the remainder of the paper, we refer to α_j as inertia, which is alternative-specific in some models.

Our models decompose the random components of families' long-term care decisions, ω_{nijt}, into (at least) two types of unobserved heterogeneity as well as an idiosyncratic error term, ε_{nijt} :

$$\omega_{nijt} = u_{ni} + \eta_{nij} + \varepsilon_{nijt}.$$

First, some elderly individuals may have preferences for certain care options that are not observed to the econometrician and hence not captured by X or Z. For example, for philosophical or cultural reasons, a particularly strong aversion to institutional care may motivate some families to avoid this mode of care. Such individual/family-alternative specific correlation across time is captured by η_{nij}. Second, there may be individual or family-specific characteristics that influence all care alternatives across time but are unobserved to the econometrician. For example, high levels of wealth may enable a family to purchase formal care rather than to rely exclusively or primarily on family members. Such individual/family-specific correlation across time and alternatives is captured by u_{ni}. As shown in the following subsections, the assumed distributions of u_{ni}, η_{nij}, and ε_{nijt} vary across our three models. For ease of exposition, we drop the family subscript in the following subsections.

4.1 Multiple Caregiver Model

In our first model, we consider a caregiving choice for an elderly individual ignoring any interactions across care alternatives. The family decides whether to use a caregiving option taking into account the characteristics of the potential or actual care recipient, characteristics of the potential or actual care arrangements, and whether that care alternative was selected the previous period.

We estimate a dynamic multivariate probit model, where the baseline latent value to alternative j is given in equation (1). We assume $\varepsilon_{ijt} \sim iidN(0,1)$, $u_i \sim iidN\left(0,\sigma_u^2\right)$, and $\eta_{ij} \sim iidN\left(0,\sigma_\eta^2\right)$ and define $F_{u,\eta}(\cdot)$ as the joint distribution of u and η. Family n uses alternative j to provide help for individual i at time t if

$$y_{ijt} = 1\left(y_{ijt}^{*} > 0\right).$$

Define

$$V_{ijt}^{m}(\theta^m) = X_{it}\beta_j + Z_{ijt}\gamma + \alpha_j y_{ijt-1} + u_i + \eta_{ij},$$

where y_{ijt-1} equals one if alternative j was chosen last period. Then, the likelihood contribution for (a living) elderly individual i is

$$\mathcal{L}_i = \int\int \prod_{t=1}^{T} \prod_{j=-3}^{J_n} \Phi\left(V_{ijt}^{m}\right)^{y_{ijt}} \left[1-\Phi(V_{ijt}^{m})\right]^{1-y_{ijt}} dF_{u,\eta}(u,\eta)$$

where $\theta^m = (\beta,\gamma,\alpha,\sigma_\eta,\sigma_u)$ is the vector of parameters to estimate and the superscript "m" denotes "multiple caregiver."

4.2 Multiple Caregiver Results

Table 4 presents the results of a static multivariate probit model where care arrangements in the previous period do not influence current care arrangements (i.e., α_j is forced to be 0). These results provide a baseline with which to compare the results of a model that allows for the possibility of inertia in care arrangements.

Controlling for race/ethnicity, marital status, age, activity limitations, educational attainment, and several characteristics of the spouse, elderly men are statistically significantly more likely to receive each mode of care than are elderly women. Although inconsistent with some of the findings in the literature (e.g., McGarry, 1998; Pezzin and Schone, 1999; Checkovich and Stern, 2002; Van Houtven and Norton, 2004), our previous work suggests that care provided to mothers is less effective (albeit also less burdensome) than care provided to fathers (Byrne, Goeree, Hiedemann and Stern, 2009).

Not surprisingly, an elderly individual's marital status is a statistically significant determinant of care arrangements. Married individuals are less likely to receive care provided by a child, formal home health care, or institutional care than are their unmarried counterparts. Consistent with findings in the literature (e.g., Stern 1995), these results suggest that spouses are an important source of care for one another. Also consistent with other studies (e.g., McGarry, 1998), Black and Hispanic elderly individuals face statistically significantly lower probabilities than their white counterparts of receiving care from an adult child after controlling for relevant characteristics.

Educational attainment may also influence care arrangements. For example, our results suggest that elderly individuals with a high school or college degree may be more likely to receive formal modes of care than are their less educated counterparts; however, not all of the relevant coefficients are statistically significant. The likelihood of receiving care from a child or child-in-law depends negatively on the educational attainment of the elderly individual's spouse. However there is no clear pattern concerning the relationship between the spouse's educational attainment and the likelihood that the spouse provides care: those with a high school degree are statistically significantly more likely to provide care than are those without a high school degree, while those with a college degree are less likely to provide care than are those without a high school degree.

Not surprisingly, as an elderly individual develops more problems with activities or instrumental activities of daily living, the likelihood of receiving each mode of care increases. The health of the spouse also influences care arrangements. In particular, the number of ADL problems experienced by the spouse is positively associated with the likelihood that the individual receives informal care from a child and/or formal home health care. In addition, care provided by the spouse depends negatively on the number of the spouse's own IADL problems. Controlling for activity limitations, informal care is less likely as the individual ages. As the spouse ages, the individual faces higher probabilities of receiving each form of care – including care provided by the spouse.

Our results also shed light on the role of adult children's characteristics in families' long-term care arrangements for the elderly. Consistent with the literature (e.g., Sloan, Picone and Hoerger, 1997; Wolf, Freedman and Soldo, 1997; Checkovich and Stern, 2002; Engers and Stern, 2002), our results indicate that daughters are more likely to provide care than are sons. As expected, proximity to or coresidence with an elderly parent is positively and statistically significantly associated with receiving informal care from a child. Also, informal care from a child is positively associated with the child's years of schooling.

Market conditions and public policies in the elderly individual's state of residence also influence care arrangements. After controlling for activity limitations, the use of formal home health care depends negatively on the average wages of home health care providers. The generosity of a state's income limits facing individuals for Medicaid coverage of formal health care is negatively associated with the use of formal home health care and positively associated with the use of institutional care; both of these relationships are statistically significant. In contrast, the generosity of a state's Medicaid income limits facing couples has the opposite effects on these two forms of care, although the relationship between income limits and care arrangements is statistically significant only in the case of formal home health care. Not surprisingly, institutional care is a more attractive option in states with greater nursing home staff hours per nursing home resident. Finally, the use of institutional care is positively associated with the overall disability level among nursing home residents in the state.

As discussed earlier, prior care arrangements may influence decisions concerning current care arrangements. For instance, elderly individuals may become accustomed to care by a home health care provider and, hence, the family may continue relying on this mode of care. Alternatively, moving to a nursing home requires a substantial lifestyle change as well as (dis)investments that may be difficult to reverse such as selling a home. Accordingly our dynamic model allows for the possibility of inertia in care arrangements. Specifically, our approach allows us to isolate the impact of inertia (i.e., true state dependence) from other forms of persistence in care arrangements (i.e., spurious state dependence) by controlling for both observed and unobserved heterogeneity. In our Dynamic Multiple Caregiver Model, we allow for inertia in each care alternative (i.e., we relax the assumption that α_j equals 0).

Variable	Informal Care by Spouse Estimate	Std Err	Informal Care by Child Estimate	Std Err	Formal Home Health Care Estimate	Std Err	Institutional Care Estimate	Std Err
Parent and Spouse Characteristics								
Constant	-4.435 **	0.185	-1.650 **	0.265	-2.137 **	0.854	-6.038 **	1.947
Female	-0.435 **	0.077	-0.924 **	0.072	-0.616 **	0.131	-0.892 **	0.146
Black	-0.105	0.148	-0.397 **	0.109	-0.016	0.245	0.118	0.253
Hispanic	-0.056	0.326	-0.276 *	0.168	0.189	0.249		
Married			-5.670 **	0.261	-3.698 **	0.862	-6.394 **	0.965
Age	-0.012 **	0.005	-0.018 **	0.003	-0.005	0.006	0.002	0.006
Spouse Age	0.051 **	0.005	0.066 **	0.003	0.050 **	0.008	0.084 **	0.009
HS Diploma	-0.043	0.099	0.179 **	0.074	0.268 *	0.154	0.141	0.201
College Degree	-0.079	0.104	0.052	0.086	0.209	0.164	0.304 *	0.189
Spouse HS Diploma	0.155 *	0.100	-0.252 **	0.096	0.117	0.191	0.357	0.270
Spouse College Degree	-0.170 *	0.104	-0.342 **	0.120	0.021	0.213	-0.326	0.310
# ADLs	0.093 **	0.025	0.070 **	0.016	0.161 **	0.031	0.236 **	0.047
# IADLs	0.485 **	0.029	0.341 **	0.021	0.235 **	0.045	0.273 **	0.049
# Spouse ADLs	0.042	0.029	0.074 **	0.036	0.122 **	0.057	0.121	0.082
# Spouse IADLS	-0.114 **	0.030	0.165 **	0.046	0.154 **	0.059	0.183 *	0.094
Child Characteristics								
Female			0.360 **	0.056				
Age			0.002	0.004				
Education			0.026 *	0.015				
# Kids			-0.019	0.020				
Working			-0.003	0.002				
Married			-0.047	0.070				
Child Lives Within 10 Miles			0.501 **	0.059				
Child Lives With Parent			1.144 **	0.094				
Local Characteristics								
Home Health Care Per Week ($100)					-2.331 **	0.608		
Medically Needy Program					-0.039	0.168	0.251	0.373
SSI Income Limit 1Person ($1000)					-0.568 *	0.324	1.630 *	0.942
SSI Income Limit 2 Person ($1000)					1.317 **	0.267	-0.291	0.617
NH Beds Per Population > 70							0.183	0.300
ADL Score							2.117 **	1.023
Nursing Hours							0.985 **	0.432
Standard Deviation Person-Alternative Error (Restricted)					0.104 **	0.039		
Standard Deviation Person Error					0.857 **	0.038		

Table 4: Multiple Caregiver: Static Multivariate Probit Estimates

We present estimates of this dynamic model in Table 5. The results of this model highlight the importance of controlling for unobserved heterogeneity over time, as the estimate of the standard deviation person error (σ_η) is statistically significantly different from 0. Unobserved characteristics such as wealth and chronic health conditions unrelated to (I)ADL problems may contribute to persistence (in this case, spurious state dependence) in care arrangements. Moreover, the results indicate that there is strong statistically significant inertia (i.e., true state dependence) across all caregiving choices. Given the high transition costs associated with institutional care, it is not surprising that nursing home care exhibits state dependence. Similarly, the state dependence associated with informal care may reflect lifestyle or schedule changes that enable an adult child or spouse to provide care for an elderly individual. And, as discussed above, an elderly individual may develop an attachment to a formal home health care provider, leading to inertia in this mode of care as well.

Most of the parameter estimates in the dynamic model are consistent in sign with those in the static model, but the impact of some variables is smaller and less statistically significant in the dynamic model. The differences in magnitude and statistical significance across the two versions of the model suggest that some characteristics matter more in the initial choice of the care arrangement – particularly in the case of institutional care – than in the current decision conditional on previous arrangements. For example, the generosity of a state's Medicaid policy facing individuals is a statistically significant predictor of institutional care in the static but not in the dynamic model. Similarly, the effects of nursing home staff hours per nursing home resident and the overall level of disability among nursing home residents in the state have smaller and less significant effects on the likelihood of selecting nursing home care conditional on past choices. Evidence of inertia in care arrangements combined with the sensitivity of parameter estimates across these two models underscore the importance of developing models that capture intertemporal patterns of care.

Variable	Informal Care by Spouse Estimate	Std Err	Informal Care by Child Estimate	Std Err	Formal Home Health Care Estimate	Std Err	Institutional Care Estimate	Std Err
Inertia Effect	0.801 **	0.077	1.437 **	0.097	1.082 **	0.186	2.103 **	0.402
Parent and Spouse Characteristics								
Constant	-3.834 **	0.181	-1.480 **	0.276	-2.026 **	0.893	-6.228 **	2.002
Female	-0.373 **	0.076	-0.809 **	0.067	-0.540 **	0.143	-0.848 **	0.154
Black	-0.098	0.152	-0.359 **	0.109	-0.102	0.243	-0.012	0.265
Hispanic	-0.021	0.335	-0.271	0.194	0.153	0.269		
Married			-4.446 **	0.251	-2.598 **	0.865	-5.472 **	0.950
Age	-0.012 **	0.006	-0.015 **	0.003	-0.003	0.006	-0.001	0.006
Spouse Age	0.043 **	0.006	0.051 **	0.003	0.037 **	0.008	0.073 **	0.009
HS Diploma	-0.045	0.099	0.152 **	0.076	0.212	0.165	0.139	0.211
College Degree	-0.082	0.105	0.027	0.087	0.146	0.176	0.256	0.196
Spouse HS Diploma	0.128	0.100	-0.195 *	0.101	0.088	0.211	0.166	0.300
Spouse College Degree	-0.124	0.105	-0.208 *	0.131	0.104	0.235	-0.304	0.326
# ADLs	0.057 **	0.025	0.057 **	0.016	0.143 **	0.033	0.199 **	0.049
# IADLs	0.439 **	0.028	0.293 **	0.020	0.208 **	0.047	0.252 **	0.052
# Spouse ADLs	0.034	0.029	0.034	0.037	0.092 *	0.056	0.105	0.084
# Spouse IADLS	-0.103 **	0.029	0.171 **	0.046	0.129 **	0.058	0.145	0.095
Child Characteristics								
Female			0.273 **	0.063				
Age			-0.001	0.005				
Education			0.020	0.016				
# Kids			-0.016	0.022				
Working			-0.002	0.002				
Married			-0.070	0.077				
Child Lives Within 10 Miles			0.390 **	0.066				
Child Lives With Parent			0.891 **	0.102				
Local Characteristics								
Home Health Care Per Week ($100)					-2.038 **	0.652		
Medically Needy Program					0.052	0.182	0.073	0.354
SSI Income Limit 1Person ($1000)					-0.188	0.332	1.297	1.011
SSI Income Limit 2 Person ($1000)					1.052 **	0.293	-0.449	0.662
NH Beds Per Population > 70							0.154	0.317
ADL Score							1.717 *	1.120
Nursing Hours							0.764 *	0.486
Standard Deviation Person-Alternative Error (Restricted)					0.026	0.056		
Standard Deviation Person Error					0.614 **	0.037		

Table 5: Multiple Caregiver: Dynamic Multivariate Probit Estimates

4.3 Primary Caregiver Model

In this section, we model the primary source of care for an elderly individual. This model is particularly useful in that it allows us to compare our results to many previous papers in the long-term-care literature that focus on the family's selection of the primary care arrangement.

We estimate a multinomial mixed logit model (McFadden and Train, 2000) where the baseline latent value to alternative j is given in equation (1) with one modification. There may be individual/time-specific correlation across care alternatives that is not captured by our observables. If this is not accounted for in estimation, the estimate for inertia may be correlated with the error term. To address this issue, we augment the baseline latent value given in equation (1) to incorporate individual/time unobserved heterogeneity, denoted v_{it}. Specifically, unobserved components are now given by

$$\omega_{ijt} = \delta_j u_i + \lambda_j v_{it} + \eta_{ij} + \varepsilon_{ijt}, \tag{2}$$

where we assume

$$\begin{aligned} u &\sim iidN(0, \Omega_u) \\ v_t &\sim iidN\left(0, \Omega_v\right) \\ \eta_j &\sim iidN\left(0, \Omega_\eta\right) \\ \varepsilon_{ijt} &\sim iidEV. \end{aligned}$$

The δ_j and λ_j terms are alternative-specific factor loadings. The variance terms of Ω_u and Ω_v are restricted to one for identification, and the off-diagonal terms are estimated.[7] The Ω_η matrix is specified as

$$\begin{pmatrix} e^{\vartheta_{\eta 11}} & \frac{2e^{\vartheta_{\eta 21}}}{1+e^{\vartheta_{\eta 21}}} - 1 \\ \frac{2e^{\vartheta_{\eta 21}}}{1+e^{\vartheta_{\eta 21}}} - 1 & e^{\vartheta_{\eta 22}} \end{pmatrix}.$$

Assume the family chooses the alternative that provides the highest latent value

$$y_{ijt} = 1\left(y^*_{ijt} \geq y^*_{ikt} \forall k \neq j, k \in S_{it}\right),$$

where the set of care alternatives at time t is denoted S_{it}. Let

[7] Specifically,

$$\Omega_u = \begin{pmatrix} 1 & \frac{2e^{\vartheta_u}}{1+e^{\vartheta_u}} - 1 \\ \frac{2e^{\vartheta_u}}{1+e^{\vartheta_u}} - 1 & 1 \end{pmatrix}.$$

The variance terms of Ω_u are restricted to be one because u_i is multiplied by an alternative-specific factor loading (δ_j) so the variance terms are not identified. The transformation in the off-diagonal term insures that $-1 \leq \Omega_{u21} \leq 1$ which is necessary for the variance terms to be one.

$$V_{ijt}^{p}\left(\theta^{p}\right)=X_{it}\beta_{j}+Z_{ijt}\gamma+\alpha y_{ijt-1}+\delta_{j}u_{i}+\lambda_{j}v_{it}+\eta_{ij},$$

with parameters given by $\theta^{p}=(\beta,\gamma,\alpha,\delta,\lambda,\Omega_{u},\Omega_{v},\Omega_{\eta})$ (the superscript "p" denotes "primary caregiver"). The lagged care decision, y_{ijt-1}, is a dummy variable equal to one if care arrangement j was the primary arrangement in the previous period. Let $a_{it}=1$ be an indicator variable for whether individual i is living at time t. Then the likelihood contribution for a family is

$$\mathcal{L}_{n}=\int\int\int\prod_{i=1}^{2}\prod_{t=1}^{T}\left(\frac{\exp\left\{V_{ijt}^{p}\right\}}{\sum_{k\in S_{it}}\exp\left\{V_{ikt}^{p}\right\}}\right)^{a_{it}}dF_{u,\eta,v}(u,\eta,v) \tag{3}$$

where $F_{u,\eta,v}(\cdot)$ is the joint distribution of the unobservables. There is no closed form solution to equation (3), so we estimate the model using simulated ML. The simulated likelihood contribution is

$$\mathcal{L}_{n}=\frac{1}{R}\sum_{r=1}^{R}\prod_{i=1}^{2}\prod_{t=1}^{T}\left(\frac{\exp\left\{V_{ijt}^{p}\left(\eta_{ij}^{r},u_{i}^{r},v_{it}^{r},\theta^{p}\right)\right\}}{\sum_{k\in S_{it}}\exp\left\{V_{irt}^{p}\left(\eta_{ik}^{r},u_{i}^{r},v_{it}^{r},\theta^{p}\right)\right\}}\right)^{a_{it}},$$

where $\left(\eta_{ij}^{r},u_{i}^{r},v_{it}^{r}\right)$ are errors simulated from their respective densities (see Boersch-Supan et. al., 1988; Hajivassiliou et. al., 1996). The estimate of the asymptotic covariance matrix is the usual

$$\left[\frac{1}{N}\sum_{n}\frac{\partial\log\mathcal{L}_{n}\left(\widehat{\theta^{p}}\right)}{\partial\theta^{p}}\frac{\partial\log\mathcal{L}_{n}\left(\widehat{\theta^{p}}\right)}{\partial\theta^{p}}\right]^{-1}$$

where $\widehat{\theta^{p}}$ is the simulated MLE of θ^{p}.[8]

4.4 Primary Caregiver Results

Table 6 presents multinomial mixed logit parameter estimates for the choice of the primary care arrangement. In this model, the family selects a primary care arrangement (from all available options) for each elderly individual in a particular time period taking into account the characteristics of the potential or actual care recipient, the characteristics of the potential or actual caregivers, and the primary care arrangement selected the previous period.

[8] We use antithetic acceleration in simulation. Geweke (1988) shows that if antithetic acceleration is implemented during simulation, then the loss in precision is of order $1/N$ (where N are the number of observations), which requires no adjustment to the asymptotic covariance matrix.

Consistent with the Multiple Caregiver Model, the results of the Primary Caregiver Model provide evidence that inertia plays a role in families' care arrangements for the elderly. Specifically, we find statistically significant positive inertia in the choice of the primary care arrangement (1.129), after controlling for observed and unobserved heterogeneity.

Not surprisingly, several demographic characteristics that influence whether an individual receives a particular mode of care also influence whether that mode is the individual's primary care arrangement. For example, while the Multiple Caregiver Model indicates that elderly men are statistically significantly more likely to receive each mode of care than are elderly women, the Primary Caregiver Model indicates that elderly men are significantly more likely than are elderly women to receive each potential mode of care as their primary care arrangement relative to not receiving any care. Also consistent with the Multiple Caregiver Model, Black elderly individuals face statistically significantly lower probabilities than their white counterparts of receiving care from an adult child as their primary care arrangement relative to not receiving any care. And here too marriage significantly reduces the likelihood of receiving a non-spousal primary care arrangement relative to receiving care from a spouse or no care.

The implications concerning the role of an individual's own activity limitations and those of her spouse are similar across the two dynamic discrete choice models. As discussed earlier, as an individual develops more (I)ADL problems, the probability that she receives each potential mode of care increases; likewise, her chance of receiving each mode of care as her primary arrangement increases relative to the outcome where she receives no care. Also consistent with the Multiple Caregiver Model, the number of ADL problems experienced by the spouse is positively and significantly associated with the likelihood that the individual receives formal home health care as the primary care arrangement relative to the outcome where she receives no care. Surprisingly, the likelihood that the spouse serves as the primary caregiver relative to the outcome where the individual receives no care is positively associated with the number of ADL problems experienced by the spouse. But, as expected, the likelihood that the individual relies on non-spousal care as her primary arrangement relative to the outcome where she receives no care depends positively (and, with the exception of formal home health care, significantly) on the number of IADL problems experienced by the spouse. Consistent with the Multiple Caregiver Model, as the spouse accumulates IADL problems, the individual is significantly less likely to rely on spousal care as the primary arrangement relative to the outcome where she receives no care.

Variable	Estimate	Std Err	Informal Care by Spouse Estimate	Std Err	Informal Care by Child Estimate	Std Err	Formal Home Health Care Estimate	Std Err	Institutional Care Estimate	Std Err
Inertia Effect	1.129 **	0.066								
Parent and Spouse Characteristics										
Constant			-2.330 **	0.366	-4.325 **	0.930	-5.279 **	2.622	-15.769 **	5.019
Female			-1.291 **	0.183	-3.355 **	0.283	-2.726 **	0.394	-4.108 **	0.566
Black			-0.321	0.274	-1.391 **	0.361	-0.357	0.695	-0.274	0.666
Hispanic			0.142	0.521	-0.125	0.422	-0.458	1.062		
Married					-6.899 **	1.344	-8.150 **	3.420	-8.632 **	3.112
Age			0.048 **	0.016	-0.012	0.010	0.026	0.017	0.030	0.020
Spouse Age			-0.036 **	0.016	0.075 **	0.016	0.110 **	0.032	0.127 **	0.033
HS Diploma			-0.042	0.187	0.318	0.241	0.761 *	0.449	0.384	0.525
College Degree			-0.253	0.199	0.129	0.259	0.609	0.462	0.563	0.477
Spouse HS Diploma			0.085	0.190	-0.888 **	0.367	0.140	0.819	0.162	0.772
Spouse College Degree			-0.155	0.202	-0.645 *	0.406	-0.029	0.770	-0.888	0.882
# ADLs			0.084 *	0.046	0.097 *	0.055	0.201 **	0.081	0.477 **	0.119
# IADLs			0.763 **	0.057	0.802 **	0.068	0.674 **	0.117	0.912 **	0.131
# Spouse ADLs			0.133 **	0.062	0.127	0.110	0.315 *	0.170	0.206	0.199
# Spouse IADLS			-0.128 **	0.065	0.515 **	0.131	0.215	0.187	0.475 **	0.219
Person-Time-Choice Factor Loading			-0.426 **	0.107	0.199 *	0.125	0.056	0.299	-0.081	0.272
Person-Choice Factor Loading			0.256 **	0.106	1.026 **	0.141	0.770 **	0.244	1.514 **	0.261
Child Characteristics										
Female					0.659 **	0.134				
Age					0.009	0.012				
Education					0.067 *	0.040				
# Kids					-0.036	0.048				
Working					-0.004	0.004				
Married					-0.701 **	0.190				
Child Lives Within 10 Miles					0.816 **	0.177				
Child Lives With Parent					2.257 **	0.236				
Local Characteristics										
Home Health Care Per Week ($100)							-4.478 **	1.788		
Medically Needy Program							0.430	1.030	0.123	0.807
SSI Income Limit 1Person ($1000)							4.535 *	2.552	3.749 *	2.323
SSI Income Limit 2 Person ($1000)							1.131	1.625	-0.636	1.530
NH Beds Per Population > 70									-0.118	0.376
ADL Score									-0.665	0.771
Nursing Hours									2.549 **	0.668
Person-Time Effect Father-Mother	-1.000									
Person Effect Father-Mother	-1.000									
Cholesky Term Father	0.327 **	0.106								
Cholesky Term Mother	0.146	0.121								
Cholesky Term Father-Mother	-0.821 **	0.098								

Notes: The parameter in the Cholesky decomposition for the Person-Time Effect was diverging to negative infinity so we restricted it to exp(-7), which implies a Person-Time Effect of -1.000. Analogously for the Person Effect.

Table 6: Primary Caregiver: Multinomial Mixed Logit Estimates

Although the model only explicitly controls for health limitations that relate to activities and instrumental activities of daily living, the person-time-choice factor loading (λ_j) may capture the role of temporary health conditions unrelated to (I)ADL limitations. Estimates for this factor loading indicate that person-time-specific heterogeneity significantly influences the probabilities associated with the two informal care arrangements relative to the probability that the elderly individual receives no care. Thus, the results of this model suggest that temporary health conditions unrelated to (I)ADL limitations may change the relative attractiveness of each informal care mode and hence may induce a change in the individual's primary care arrangement.

In the absence of information concerning income and wealth, education may serve as a proxy for an individual's or family's financial well-being. Consistent with the dynamic Multiple Caregiver Model, the Primary Caregiver Model does not provide strong evidence relating the elderly individual's educational attainment to the selection of the primary care arrangement. However, the person-choice factor loading (δ_j) estimates indicate that person-specific unobservables, which influence all care alternatives across time, are significantly related to the probability of each potential primary care arrangement relative to the outcome where the individual receives no care. For example, an individual's wealth may increase the likelihood that she receives some form of care. Finally, the spouse's educational attainment is significantly associated with the likelihood that the child serves as the primary caregiver. Compared to individuals whose spouse does not have a high school degree, those with more highly educated spouses are less likely to receive informal care from a child as their primary arrangement relative to not receiving any care.

While the implications concerning most characteristics of the older generation are similar across the two dynamic discrete choice models, a comparison of the two models also reveals some interesting differences. For example, while the use of any informal care becomes significantly less likely as the individual ages, older individuals are significantly more likely to rely on spousal care as their primary arrangement relative to the outcome where they receive no care. As the spouse ages, an elderly individual is more likely to receive any spousal care but less likely to rely on spousal care as her primary care arrangement.

With regard to the characteristics of the younger generation, the implications of the two dynamic discrete choice models are similar. Relative to sons, daughters are significantly more likely to provide informal care, and they are also significantly more likely to serve as the primary caregiver for an elderly parent. Similarly, adult children who live with or near their elderly parents are significantly more likely to provide any assistance or to serve as the primary caregiver. In both models, marriage is negatively associated with the provision of informal care by a child but the relationship is statistically significant only in the Primary Caregiver Model. Similarly, both models suggest that more highly educated children are more likely to provide care but the relationship between a child's education and the likelihood that she provides care is statistically significant only in the Primary Caregiver Model.

Market conditions and public policies influence not only the decision to use formal care arrangements but also the choice of the primary care arrangement. As discussed earlier, the use of formal home health care depends negatively on the average wages of home health care providers. Similarly, the likelihood that formal home health care is selected as the primary care arrangement depends negatively on the cost of home health aide workers. In both models, the decision to use institutional care is positively and significantly associated with the nursing home staff hours per nursing home resident in the elderly individual's state of residence.

The two discrete choice models offer conflicting evidence concerning Medicaid policy. In the dynamic Multiple Caregiver Model, the state's income limit facing individuals for Medicaid coverage of formal home health care or institutional care is not significantly associated with the use of formal care. However, the Primary Caregiver Model indicates that families are significantly more likely to select one of the formal care modes as the primary care arrangement as the state's income limits facing individuals become more generous. In contrast, the generosity of a state's Medicaid limits facing couples, while significantly related to the use of formal home health care in the Multiple Caregiver Model, does not play a statistically significant role in the choice of the primary care arrangement.

4.5 Hours of Care Model

An important dimension of caregiving decisions concerns how much care to provide. Following Sloan, Picone, and Hoerger (1997), Wolf, Freedman, and Soldo (1997), Pezzin and Schone (1999b), Checkovich and Stern (2002), and Byrne et al. (2009), we next consider the continuous choice associated with caregiving alternatives. As discussed earlier, families may rely on more than one mode of care. For example, an elderly individual may receive informal care provided by a child together with formal care provided by a home health aide. As this example suggests, various caregiving alternatives – and the amount provided – may be substitutable to some extent. Moreover, the quantity of care received in the past could impact the value associated with the quantity of that care alternative provided today. Accordingly, we develop a model of hours of care that allows for the possibility of multiple care arrangements, while linking arrangements over time.

We estimate a dynamic multivariate tobit model, where we augment the baseline latent value of care in equation (1) to allow for (i) substitution across modes of care and (ii) different inertia effects. Specifically, the latent value associated with the amount of time spent using the jth care provision is given by

$$y^*_{ijt} = X_{it}\beta_j + Z_{ijt}\gamma + \rho_j \sum_{j' \neq j} y_{ij'} + \alpha_j^{\text{thresh}} 1\left(y_{ijt-1} > 0\right) + \alpha_j^{\text{marg}} y_{ijt-1} + \omega_{ijt}, \tag{4}$$

where the observed continuous value of caregiving is given by $y_{ijt} = \max(0, y^*_{ijt})$. As in Checkovich and Stern (2002), substitution in total care provided across alternatives is captured by $\rho_j \sum\limits_{j' \neq j} y_{ij'}$. The α_j terms capture inertia in caregiving where the amount of care provided of mode j depends both on whether j was chosen in the previous period (captured by the threshold value of inertia, α^{thresh}) as well as the quantity of alternative j provided in the previous period (captured by the marginal value of inertia, α^{marg}).[9]

Similar to the Primary Caregiver Model, this model decomposes the random components of families' long-term care decisions into three types of unobserved heterogeneity as well as an idiosyncratic error term:

$$\omega_{ijt} = u_i + \eta_{ij} + v_{it} + \varepsilon_{ijt},$$

[9] We can think of equation (4) as a set of structural equations, one for each alternative available to the family. If we ignore the nonnegativity constraints on y_{ij}, then we can solve equation (4) to get a reduced form set of equations. Checkovich and Stern (2002) show how one can add the nonnegativity constraints in an algorithm handling nonlinearity of the reduced form. Here, instead, we focus on the structural equations directly. Checkovich and Stern (2002) state that the nonnegativity constraints lead to the potential for multiple equilibria. In the literature, the most common cause of such multiple equilibria is the inclusion of a discrete dependent variable. For example, if we were to include a term such as $\sum_{j' \neq j} 1\left(y_{ij't} > 0\right)$ or $1\left(\sum_{j' \neq j} y_{ij't} > 0\right)$ on the right-hand side of equation (4), then we would have a generalization of the problem discussed in literature on entry (see Bresnahan and Reiss, 1991; Tamer, 2003; and the discussion in Goeree and Stern, 2010). Fontaine, Gramain, and Wittwer (2009) estimate a model of family long-term care decisions with only binary interactions using estimation technology directly from Tamer (2003). In this work, we ignore issues of multiple equilibria and treat the observed outcome as the only equilibrium.

where

$$u_i \sim iidN\left(0, \sigma_u^2\right)$$

$$\eta_{ij} \sim iidN\left(0, \sigma_\eta^2\right)$$

$$v_{it} \sim iidN\left(0, \sigma_v^2\right)$$

$$\varepsilon_{ijt} \sim iidN\left(0, \sigma_\varepsilon^2\right).$$

The parameters to estimate are σ_ε and $\theta^h = (\alpha, \beta, \gamma, \rho, \sigma_u, \sigma_\eta, \sigma_v)$ and the superscript "h" denotes "hours of caregiving." Let

$$V_{ijt}^h\left(\theta^h\right) = X_{it}\beta_j + Z_{ijt}\gamma + \rho_j \sum_{j' \neq j} y_{ij'} + \alpha_j^{\text{thresh}} 1\left(y_{ijt-1} > 0\right) + \alpha_j^{\text{marg}} y_{ijt-1} + u_i + \eta_{ij} + v_{it}.$$

The set of values A_n of the idiosyncratic error ε that results in the amount of time spent using the jth care provision is given by

$$A_n \equiv \left\{\varepsilon : \varepsilon_{ijt} \begin{cases} = y_{ijt} - V_{ijt}^h(\theta^h) & \text{if } y_{ijt} > 0 \\ \leq -V_{ijt}^h\left(\theta^h\right) & \text{if } y_{ijt} = 0 \end{cases}\right\}.$$

The likelihood contribution for (a living) individual i is

$$\mathcal{L}_i = \int_{A_n} \prod_{t=1}^{T} \prod_{j=1}^{J_n} \left\{\frac{1}{\sigma_\varepsilon}\phi\left(\frac{y_{ijt} - V_{ijt}^h\left(\theta^h\right)}{\sigma_\varepsilon}\right)\right\}^{1(y_{ijt}>0)} \left\{1 - \Phi\left(\frac{V_{ijt}^h\left(\theta^h\right)}{\sigma_\varepsilon}\right)\right\}^{1(y_{ijt}=0)} dF_{u,\eta,v}(u, \eta, v). \tag{5}$$

where $F_{u,\eta,v}(\cdot)$ denotes the joint distribution of the unobservables. We simulate equation (5) using GHK. Estimating the asymptotic covariance matrix of the parameters is standard.

4.6 Hours of Care Results

Table 7 presents the results of our dynamic multivariate tobit model. Again the results highlight the importance of controlling for unobserved heterogeneity over time, as the estimate of the standard deviation person error (σ_η) is statistically significantly different from 0. The top panel of the table indicates that all modes of care exhibit statistically significant inertia. The quantity of each mode of informal care depends positively on the use of that mode of care in the previous period (0.170 and 0.365) and on the quantity provided in the previous period (0.233 and 0.532). The quantity of formal home health care in the current period is positively associated with the use of formal home health care in the previous period. However, conditional on the use of formal home health care in the previous period, the quantity of formal home health care in the current period is not significantly associated with the quantity received in the previous period. In contrast, the quantity of institutional care received last period has a positive significant effect on the quantity of institutional care received this period.

The results also indicate that there is statistically significant substitution in the quantity of care provided across modes of care. The quantity of each mode of care is positively associated with the total amount of care received from other sources.

For most of the demographic characteristics in our models, the signs and significance levels of the estimated coefficients in the continuous choice model mirror those of one or both of our dynamic discrete choice models. For example, consistent with the other two models, controlling for other relevant characteristics, elderly men receive significantly more hours of each mode of care than do elderly women, blacks receive significantly less informal care from adult children than do whites, and marriage reduces the quantities of non-spousal forms of care. Consistent with the Multiple Caregiver Model, the amount of informal care declines significantly as the individual ages; while the discrete choice models do not reveal a statistically significant relationship between age and the use of formal home health care, the continuous choice model indicates that hours of formal home health care depend positively and significantly on the elderly individual's age. Again consistent with the Multiple Caregiver Model, the quantity of each mode of care depends positively and significantly on the spouse's age.

The implications of the continuous choice model concerning the role of activity limitations are consistent with those of the discrete choice models. Not surprisingly, the number of (I)ADL problems experienced by the elderly individual is positively and significantly associated with the quantity of each mode of care. As the spouse acquires more ADL problems, the elderly individual receives significantly more formal home health care. As the spouse acquires more IADL problems, the elderly individual receives significantly less spousal care and significantly more of each of the other modes of care.

Turning to the role of the younger generation, the characteristics that influence whether a child provides care also influence the quantity of care provided. Relative to sons, daughters provide significantly more care. Similarly, adult children who live with or near their elderly parents provide significantly more assistance than do those who live far away.

Again market conditions influence families' care arrangements. As expected and consistent with the other models, the quantity of formal home health care depends negatively and significantly on the average wages of home health care providers. In line with the results of the Multiple Caregiver Model, hours of nursing home care are positively associated with the overall disability level among nursing home residents in the state. But inconsistent with the other models, the quantity of institutional care is not significantly related to nursing home staff hours per nursing home resident.

The implications of the continuous choice model concerning Medicaid policy are consistent with those of the dynamic Multiple Caregiver Model. Specifically, the generosity of a state's Medicaid limits facing couples is statistically significantly associated with the decision to use formal home health care and also with the quantity of this mode of care.

Variable	Informal Care by Spouse Estimate	Informal Care by Spouse Std Err	Informal Care by Child Estimate	Informal Care by Child Std Err	Formal Home Health Care Estimate	Formal Home Health Care Std Err	Institutional Care Estimate	Institutional Care Std Err
Inertia and Substitution Effects								
Inertia Threshhold Effect	0.170 **	0.050	0.365 **	0.043	0.414 **	0.081	0.338	0.241
Inertia Marginal Effect	0.233 **	0.106	0.532 **	0.190	0.136	0.142	1.179 **	0.337
Substitution Effect	0.190 **	0.052	0.371 **	0.051	0.305 **	0.061	0.772 **	0.066
Parent and Spouse Characteristics								
Constant	-1.298 **	0.044	-0.613 **	0.087	-1.002 **	0.277	-2.589 **	0.658
Female	-0.130 **	0.025	-0.267 **	0.028	-0.214 **	0.054	-0.291 **	0.053
Black	-0.023	0.056	-0.114 **	0.046	-0.047	0.087	0.016	0.091
Hispanic	0.057	0.091	-0.068	0.080	0.056	0.104		
Married			-1.504 **	0.045	-0.729 **	0.230	-1.466 **	0.163
Age	-0.006 **	0.002	-0.005 **	0.000	0.001 *	0.001	0.001	0.001
Spouse Age	0.016 **	0.002	0.017 **	0.000	0.011 **	0.001	0.022 **	0.001
HS Diploma	-0.033	0.033	0.048 *	0.031	0.100 *	0.064	0.017	0.088
College Degree	-0.062 *	0.036	-0.007	0.035	0.078	0.067	0.095	0.073
Spouse HS Diploma	0.029	0.034	-0.084 **	0.043	0.010	0.091	0.033	0.101
Spouse College Degree	-0.048	0.038	-0.083 *	0.053	0.035	0.096	-0.183 *	0.108
# ADLs	0.032 **	0.008	0.015 **	0.007	0.050 **	0.013	0.085 **	0.015
# IADLs	0.140 **	0.011	0.095 **	0.008	0.085 **	0.018	0.092 **	0.016
# Spouse ADLs	0.009	0.010	0.004	0.015	0.039 *	0.022	0.023	0.025
# Spouse IADLS	-0.031 **	0.011	0.057 **	0.019	0.036 *	0.023	0.078 **	0.026
Child Characteristics								
Female			0.087 **	0.027				
Age			0.000	0.001				
Education			0.004	0.006				
# Kids			-0.007	0.009				
Working			-0.001	0.001				
Married			-0.017	0.033				
Child Lives Within 10 Miles			0.123 **	0.029				
Child Lives With Parent			0.312 **	0.041				
Local Characteristics								
Home Health Care Per Week ($100)					-0.841 **	0.250		
Medically Needy Program					0.049	0.057	-0.073	0.118
SSI Income Limit 1Person ($1000)					-0.079	0.114	0.503	0.365
SSI Income Limit 2 Person ($1000)					0.456 **	0.100	-0.269	0.203
NH Beds Per Population > 70							0.066	0.121
ADL Score							0.700 *	0.416
Nursing Hours							0.285	0.189
Std Dev for Parent Effect			0.183 **	0.014				
Std Dev for Parent-Alternative Effect (Restricted)			0.001					
Std Dev for Parent-Time Effect			0.023	0.021				
Std Dev for Idiosyncratic Effect			0.401 **	0.008				

Notes: The standard deviation for the Parent-Alternative effect was close to zero so we restricted it to exp(-7).

Table 7: Hours of Caregiving: Multivariate Tobit Estimates

5 Specification and Robustness

As we discussed in section 3, the measures of income and wealth in the AHEAD data may not be reliable. Therefore, we did not include measures of income or wealth as explanatory variables in any of the models. In this section we present a number of specification checks to test whether adding income or wealth (and interactions) would significantly improve the fit of the models. Table 8 presents results from Lagrange Multiplier tests for each model specification.

Model	Specification	Joint Chi-Square Test Statistic	Joint Critical Value	Individual Chi-Square Test Statistics: Income or Wealth Interacted with: Constant	Nursing Home Limit	Medicaid Limit	Missing Wealth	Critical Value
	Income and Income interactions:							
Multiple Caregiver								
	1993 Medicaid Limits	52*	7.81	40.87*	6.96*	4.65*		3.84
	1989 Medicaid Limits	26667*	7.81	40.87*	3.44	0.36		3.84
Primary Caregiver								
	1993 Medicaid Limits	264*	7.81	202.41*	0.80	0.34		3.84
	1989 Medicaid Limits	41227*	7.81	202.41*	5.29*	2.75		3.84
Hours of Care								
	1993 Medicaid Limits	74*	7.81	60.04*	7.59*	5.21*		3.84
	1989 Medicaid Limits	30890*	7.81	60.04*	15.13*	5.23*		3.84
	Wealth and interactions using 1989 Medicaid Limits with:							
Multiple Caregiver								
	Missing Wealth Observations Excluded	8189*	7.81	3.36	3.39	3.51		3.84
	Missing Wealth Observations Dummy Variable	374*	9.49	11.76*	7.06*	7.23*	0.02	3.84
	Smoothed Limits with Missing Wealth Dummy	311*	9.49	9.33*	10.58*	7.81*	0.05	3.84
	Average Wealth Smoothed Limits with Missing Wealth Dummy	959*	9.49	23.66*	18.91*	17.23*	0.01	3.84
Primary Caregiver								
	Missing Wealth Observations Excluded	5264*	7.81	27.36*	2.14	2.72		3.84
	Missing Wealth Observations Dummy Variable	1451*	9.49	135.04*	8.73*	9.78*	0.18	3.84
	Smoothed Limits with Missing Wealth Dummy	191*	9.49	135.04*	0.07	0.00	0.18	3.84
	Average Wealth Smoothed Limits with Missing Wealth Dummy	268*	9.49	217.12*	1.34	1.26	0.04	3.84
Hours of Care								
	Missing Wealth Observations Excluded	13706*	7.81	3.42	4.77*	4.44*		3.84
	Missing Wealth Observations Dummy Variable	1911*	9.49	12.19*	16.69*	16.20*	2.29	3.84
	Smoothed Limits with Missing Wealth Dummy	289*	9.49	12.19*	23.11*	52.39*	2.29	3.84
	Average Wealth Smoothed Limits with Missing Wealth Dummy	758*	9.49	36.60*	47.02*	80.74*	0.21	3.84

Notes: The joint restrictions are on income (or wealth) and income (or wealth) interacted with medicaid limits, nursing home limits, and a wealth missing dummy (when noted). * indicates the test statistic is greater than the critical value. Critical values for the joint tests with 2 and 3 degrees of freedom are 7.81 and 9.49. The critical value for one degree of freedom (for the individual test statistics) is 3.84.

Table 8: Lagrange Multiplier Tests

The results for income (wealth) and income (wealth) interactions for each model are given in the top (bottom) panel. For each model (multiple caregiver, primary caregiver, or hours of care), we present six specification tests with two types of statistics per specification. The first is a joint chi-squared test statistic (given in the first two columns) and the second is a chi-square test statistic for each restriction separately (given in the remaining columns). The specifications are income (or wealth) and income (or wealth) interacted with nursing home reimbursement rates, Medicaid limits, and (in some specifications) a dummy variable for missing wealth observations. Overall, the results give an inconsistent picture of whether including income or wealth (and interactions) will improve the fit of the models.

For the Multiple Caregiver Model the results indicate the fit would be improved by including income and interactions using the 1993 Medicaid limits (test statistic of 57 and critical value of 7.81). If we test each restriction separately we find that each improve the fit individually: income (43), income interacted with nursing home reimburse rates (6.68), and income interacted with Medicaid income limits (4.50) with a critical value of 3.84. However, if we instead use the 1989 Medicaid income limits (which are the limits used in some of the previous literature), we find income is important (43), but that the policy interactions do not improve the model fit (2.20 and 0.04). For the Primary Caregiver Model, we again reject the null that income and interactions would not improve the model fit using either the 1993 or 1989 Medicaid limits (266 and 53073). However, if we test each restriction separately we find that the income restriction is important for both Medicaid limit years (203), but the policy interactions do not improve the model fit (1.39 and 0.62) when we use the 1993 Medicaid limits. When we use the 1989 income limits, then the nursing home income interactions improve the fit of the model (6.74). Finally, in the Hours of Care Model, both the joint restrictions and the individual restrictions indicate that including income and income interactions with policy variables will improve the fit of the model regardless of whether we use 1993 or 1989 Medicaid limits.

In the first wealth specification, we exclude observations when the information on wealth is missing. However, wealth observations may not be missing randomly, so in the remaining specifications we include a dummy variable for missing wealth. The Medicaid asset limit is a discrete cut off, but individuals who are just above the limit may spend down and, hence, behave similarly to someone who is just below the limit. To allow for this we include "smoothed" Medicaid asset limits in the third wealth specification. To reduce the influence of large fluctuations in reported wealth, in the final specification we replace contemporaneous wealth with average wealth for each individual across time. For each model and specification the joint chi-square test statistic is larger than the critical value, hence we reject the null, restricted model in favor of the unrestricted model that includes wealth and wealth interactions. However, when we examine the individual restrictions separately we again find that which variables contribute toward a better fit depend on the model and specification.

6 Conclusions

References

Börsch-Supan, Axel, Laurence J. Kotlikoff, and John N. Morris (1991), "The Dynamics of Living Arrangements of the Elderly," in *The Economics of Care of the Elderly*, Pacolet, J. and C. Wilderon (eds.), 114-35.

Bresnahan, Timothy and Peter Reiss (1991), "Econometric Models of Discrete Games," *Journal of Econometrics* 57-81.

Brown, Meta (2006), "Informal Care and the Division of End-of-Life Transfers," *Journal of Human Resources* 41(1): 191-219.

Burwell, Brian O. and Beth Jackson (1994), "The Disabled Elderly and Their Use of Long-Term Care," U.S. Department of Health and Human Services (Office of Disability, Aging, and Long-Term Care Policy) and SysteMetrics. Available online at http://aspe.hhs.gov/daltcp/reports/diseldes.htm.

Butler, Robert N. (1997), "Population Aging and Health," *British Medical Journal* 315: 1082-1084.

Byrne, David, Michelle Goeree, Bridget Hiedemann, and Steven Stern (2009), "Formal Home Health Care, Informal Care, and Family-Decision Making," *International Economic Review* 50(4): 1205-1242.

Checkovich, Tennille J. and Steven Stern (2002), "Shared Caregiving Responsibilities of Adult Siblings with Elderly Parents," *Journal of Human Resources* 37(3): 441-478.

Dostie, Benoit and Pierre Thomas Léger (2005), "The Living Arrangement Dynamics of Sick, Elderly Individuals," *Journal of Human Resources* 40(4): 989-1014.

Engers, Maxim and Steven Stern (2002), "Long-Term Care and Family Bargaining," *International Economic Review* 43(1): 73-114.

Fontaine, Romeo, Agnes Gramain, and Gerome Wittwer (2009), "Providing Care for an Elderly Parent: Interactions Among Siblings?" *Health Economics* 8(9): 1011-1029.

Garber, Alan and Thomas MaCurdy (1990), "Predicting Nursing Home Utilization Among the High-Risk Elderly," In Issues in the Economics of Aging, ed. David Wise, Chicago: Chicago University Press.

Gardner, Lara and Donna B. Gilleskie (2009), "The Effects of State Medicaid Policies on the Dynamic Savings Patterns and Medicaid Enrollment of the Elderly," NBER Working Paper 12208.

Geweke, John (1988), "Antithetic Acceleration of Monte Carlo Integration in Bayesian Inference," *Journal of Econometrics* 38: 73-89.

Goeree, Michelle and Steven Stern (2010), "Entry Games with Continous Choice Variables," Unpublished manuscript.

Hajivassiliou, Vassilis, Daniel McFadden, and Paul Ruud (1966), "Simulation of Multivariate Normal Rectangle Probabilities and their Derivatives Theoretical and Computational Results," *Journal of Econometrics* 72(1-2): 85-134.

Heitmueller, Axel and Pierre-Carl Michaud (2006), "Informal Care and Employment in England: Evidence from the British Household Panel Survey," Working Paper.

Hiedemann, Bridget and Steven Stern (1999), "Strategic Play among Family Members when Making Long-Term Care Decisions," *Journal of Economic Behavior and Organization* 40(1): 29-57.

Hoerger, Thomas J., Gabriel A. Picone, and Frank A. Sloan (1996), "Public Subsidies, Private Provision of Care and Living Arrangements of the Elderly," *Review of Economics and Statistics* 78(3): 428-440.

Komisar, Harriet L. and Lee Shirey Thompson (2007), "National Spending for Long-Term Care," The Georgetown University Long-Term Care Financing Project Fact Sheet.

Kotlikoff, Laurence J. and John N. Morris (1990), "Why Don't the Elderly Live with Their Children? A New Look," in Issues in the Economics of Aging, ed. David A. Wise, 149-172, Chicago: University of Chicago Press.

Mack, Katherine and Lee Thompson (2005), "A Decade of Informal Caregiving: Are Today's Informal Caregivers Different than Informal Caregivers a Decade Ago?" Center on an Aging Society, Data Profile, Washington, D.C.

Macken, Candace L. (1986), "A Profile of Functionally Impaired Elderly Persons Living in the Community," *Health Care Financing Review* 7: 33-50.

Martin, Cathy D. (2000), "More Than the Work: Race and Gender Differences in Caregiving Burden," *Journal of Family Issues* 21(8): 986-1005.

McFadden, Daniel and Train, Kenneth. (2000), "Mixed Multinomial Logit Models for Discrete Response," *Journal of Applied Econometrics*, 15(5): 447-470.

McGarry, Kathleen (1998), "Caring for the Elderly: The Role of Adult Children," in *Inquiries in the Economics of Aging*, ed. David A. Wise, 133-163, Chicago: University of Chicago Press.

Pezzin, Liliana E. Pezzin, Robert A. Pollak, and Barbara S. Schone (2007), "Efficiency in Family Bargaining: Living Arrangements and Caregiving Decisions of Adult Children and Disabled Elderly Parents," CESifo Economic Studies 53(1): 69-96.

Pezzin, Liliana E. and Barbara S. Schone (1999a), "Intergenerational Household Formation, Female Labor Supply and Informal Caregiving: A Bargaining Approach," *Journal of Human Resources* 34(3): 475-503.

Pezzin, Liliana E. and Barbara S. Schone (1999b), "Parental Marital Disruption and Intergenerational Transfers: An Analysis of Lone Elderly Parents and Their Children," *Demography* 36(3): 287-297.

Shirey, Lee and Laura Summer (2000), "Caregiving: Helping the Elderly with Activity Limitations," National Academy on an Aging Society, Profile, Washington, D.C.

Sloan, Frank A., Gabriel Picone, and Thomas J. Hoerger (1997), "The Supply of Children's Time to Disabled Elderly Parents," *Economic Inquiry* 35(2): 295-308.

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

Tamer, Elie (2003), "Incomplete Simultaneous Discrete Response Model with Multiple Equilibria," *Review of Economic Studies* 70(1). 147-165.

Van Houtven, Courtney Harold and Edward C. Norton (2004), "Informal Care and Health Care Use of Older Adults," *Journal of Health Economics* 23: 1159-1180.

Wolf, Douglas A., Vicki Freedman, and Beth J. Soldo (1997), "The Division of Family Labor: Care for Elderly Parents," *Journal of Gerontology: Psychological Sciences and Social Sciences* 52B(Special Issue): S102-S109.