Nov. 3rd 2006: submitted to *Health Economics*
Do not cite without permission

Proximity to death and participation in the long-term care market

France Weaver[a]

Sally C. Stearns[b]

Edward C. Norton[b]

William Spector[c]

[a]Center for Health Care and Policy Research, The Pennsylvania State University, University Park, Pennsylvania

[b]Department of Health Policy and Administration, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

c Agency for Healthcare Research and Quality, Center for Delivery, Organization, and Markets, Rockville, Maryland

Corresponding author:

France Weaver, Ph.D.
Center for Health Care and Policy Research, The Pennsylvania State University
16C Henderson Building, University Park, 16802 PA
Phone: 814 863 0848
Fax: 814 863 0846
france.weaver@psu.edu

Sponsors:

This research was funded by the Swiss Science Foundation, grant number PBSK1-106659. Additional support was provided by the Demography and Economics of Aging Research Group at The University of North Carolina at Chapel Hill, grant number NIA P30 AG024376.

Abstract

The extent to which increasing longevity increases *per capita* demand for long-term care depends on the degree to which utilization is concentrated at the end of life. We estimate the marginal effect of proximity to death, measured by being within two years of death, on the probabilities of nursing home and formal home care use and determine whether this effect differs by availability of informal care —i.e. marital status and co-residence with an adult child. The analysis uses a sample of elderly aged 70+ from the 1993-2002 Health and Retirement Study. Multivariate probit models address the simultaneity of the decisions to use long-term care and co-reside with an adult child. Overall, proximity to death significantly increases the probability of nursing home use by 50.0 percent and of formal home care use by 12.4 percent. Availability of informal support significantly reduces the effect of proximity to death. Among married elderly, proximity to death has no effect on institutionalization. In conclusion, proximity to death is one of the main drivers of long-term care use, but changes in sources of informal support, such as an increase in the proportion of married elderly, may lessen its importance in shaping the demand for long-term care.

Key words: Proximity to death, long-term care, informal care

Introduction

Concerns about the growth in long-term care expenditures have intensified over the last decade because of the aging of the baby boom generations and the ongoing increase in life expectancy [1]. The growing elderly population will undoubtedly increase the pool of persons in need of long-term care. However, if the use of long-term care is concentrated at the end of life, increasing longevity may not increase the *per capita* demand for long-term care substantially. Therefore, the overall demand for long-term care may not increase as much as anticipated by some researchers and policy makers.

A growing body of literature documents that proximity to death, rather than age, is the main determinant of acute and post-acute care expenditures at the end of life [2-7]. As elderly persons get closer to death, their use of health care services increases, not because they become older *per se*, but because their health deteriorates. Proximity to death captures the deterioration in health associated with the mortality process, while age and other indicators of health status capture the health decline due to morbidity. Accounting for the effect of proximity to death results in lower estimates of future Medicare expenditures [8-9]. Disentangling the effect of proximity to death from the effect of age on the use of long-term care has received limited attention and is not well understood [10-11]. This study estimates the marginal effect of proximity to death on the use of nursing home and formal (paid) in-home care to assess the extent to which

increasing longevity is likely to raise individual participation in the long-term care market.

Besides health status, another major determinant of the demand for long-term care is the availability of informal care. Care provided by family members and friends is usually a substitute to nursing home and formal home care use [12-14]. Typically, the primary caregivers of married elderly are spouses, while children care for unmarried parents [15-16]. However, the availability of informal care is changing over time. Availability of spousal care is currently growing because of the documented increase in the proportion of married elderly [1]. At the same time, support from children may be reduced due to declining fertility rates and competing demands on adult children [17-18]. In the context of increasing longevity and changing informal support, we estimate the effect of proximity to death by availability and sources of informal care — i.e., by marital status and whether the elderly co-reside with an adult child.

The probabilities of nursing home and formal home care use are estimated by multivariate probit models, which provide consistent estimates when correcting for the simultaneity of multiple dichotomous decisions [19]. The probability of nursing home use is modeled as being determined simultaneously with the probability of co-residing with an adult child and its interaction with proximity to death. A similar simultaneous estimation is conducted for the probability of formal home care use. The estimates provide insight into the interaction between some of the most important factors affecting future long-term care use.

Background

Health care expenditures increase substantially in the last years of life and with age at death [20-22]. However, the pattern of use before death differs for acute care and long-term care. Spillman and Lubitz (2000) show that hospital and physician expenditures increase at a decreasing rate and nursing home expenditures increase at an accelerating rate with age at death. One limitation of these studies is that they do not separate the effect of age from the effect of proximity to death. The increase in use of health care services may not be due to the aging of the population *per se*, but to the fact that utilization is concentrated at the end of life. Disentangling these two phenomena is particularly important in the context of increasing longevity. If life expectancy remains constant, age can be used by itself to consistently estimate the demand for long-term care. If life expectancy increases over time, as observed over the last decades, omitting proximity to death overestimates the effect of age and therefore the predictions of future health care expenditures [8-9]

Proximity to death and long-term care use

There is limited and conflicting evidence of the effects of age and proximity to death on long-term care use [10-11]. Estimating a linear probability model on the 1992 Medicare Current Beneficiaries Survey, Cutler and Sheiner (1998) find that being within two years of death has a positive and significant effect on the probability of nursing home use. The impact of age on institutionalization diminishes considerably once controlling for proximity to death. Yang and colleagues (2003) conduct a graphical

analysis and illustrate that Medicaid and nursing home expenditures increase steadily with age, regardless of proximity to death. Home health expenditures increase slightly with age and time to death.

Not only is life expectancy increasing, but disability, a major determinant of long-term care use, is also changing over time [23-25]. Some studies show that disability and time to death have independent effects on health care expenditures, while age has either a small effect or is not significant [6, 11, 26]. These three measures may capture different dimensions of health deterioration. Proximity to death may reflect irreversible degradation in the physiological functions when approaching death. Disability, traditionally measured by limitations in activity of daily living (ADL) and instrumental activity of daily living (IADL), depicts chronic dimensions of the deterioration in health, which are not experienced by all individuals. Such morbidity process may or may not be related to the mortality process. Once the mortality and morbidity processes are controlled for, age captures any remaining needs related to aging itself. The present study determines whether proximity to death significantly increases the likelihood of participating in the long-term care market, when controlling for age and disability severity.

Sources of informal home care and proximity to death

In the long-term care literature, separate attention is usually paid to the effects of aging [27-28] and informal care [12-14]. In the present study, we look at the interplay between these two major determinants of nursing home and formal home care use. Because informal care is usually a substitute to nursing home and formal home care use,

we hypothesize that availability of informal support mitigates the effect of proximity to death. Stated differently, the effect of proximity to death is expected to be smaller among married and co-residing elderly than among non-married elderly.

The effects of availability of informal care on formal long-term care use may depend on the relationship between the caregivers and the elderly persons [29-30]. Freedman (1996) shows that being married reduces the likelihood of institutionalization more than having a daughter as caregiver. Newman and Struyk (1990) document that help provided by a spouse is associated with a lower risk of institutionalization, while help from other persons result in a higher likelihood of nursing home use. Such differences can be explained by different opportunity costs for retired spouses and middle-aged children who are still part of the work force, distinct motivations and social justifications to provide care for spouses and children, or by different preferences of the care providers and recipients. Therefore, the effect of proximity to death may differ whether spousal care or support from children is available.

In this study, availability of spousal care is measured by marital status and availability of informal care from children is measured by co-residence with an adult child. This latter indicator is selected for two reasons. First, the decision to move in with an aging parent, or to have an elderly parent move in with a child, is often motivated by the need to supervise and provide some support to that aging person. In that regard, co-residence with an adult child is a less noisy indicator of available support from children than other potential measures, such as having children living close by. Second, such

living arrangement is comparable to being married to the extent that in both cases the potential caregiver resides with the elderly person.

Hypotheses

To summarize, this study tests three hypotheses:

1. Proximity to death increases the probability of institutionalization and the probability of formal home care use.
2. Proximity to death has a smaller effect among married elderly and those co-residing with an adult child than among non-married elderly.
3. The effect of proximity to death differs by source of informal support, i.e., married elderly and the ones residing with an adult child.

Methods

Empirical model

To test these hypotheses, we use panel data to estimate two separate models: the probability of institutionalization and the probability of formal home care use. The dependent variables are dichotomous indicators of whether individual *i* is institutionalized or has any formal home care use at the time of interview *t* ($\Pr[Y_{it}=1]$). The formal home care model is conditional on residing in the community, as opposed to being institutionalized. We rely on interaction terms to test whether the effect of proximity to death differs by availability and sources of informal support. Specifically, these two models are specified as functions of proximity to death, measured by a dichotomous indicator of being within two years of death (PTD_{it}), its interaction with

being married ($PTD_{it} \times Married_{it}$) and co-residing with an adult child ($PTD_{it} \times Rchild_{it}$), age, and other explanatory variables correlated with the variables of interest and long-term care use:

$$\Pr[Y_{it}=1] = \alpha_0 + \alpha_1 PTD_{it} + \alpha_2 PTD_{it} \times Married_{it} + \alpha_3 PTD_{it} \times Rchild_{it} + \alpha_4 Married_{it} + \alpha_5 Rchild_{it} + \alpha_6 Age_{it} + \alpha_7 Controls_{it} + \varepsilon_{it} \quad (1)$$

Married elderly also include the elderly living with a partner without being legally married. These cohabiting elderly represent a very small fraction of our sample and the results reported below are not sensitive to including cohabiting elderly in the *Married* variable. Age has a quadratic form to capture potential non-linear effects. The control variables ($Controls_{it}$) includes the following factors. Disability is measured by having difficulties with ADLs and IADLs. Two sets of three dichotomous variables indicate the number of limitations: 1 ADL, 2-3 ADLs, 4-5 ADLs, with no ADL as reference category, and similarly for the number of IADLs. The cognitive level of the participants is assessed by a set of 10 questions testing their memory ability. Low cognition is defined as having five or fewer correct answers. The socioeconomic characteristics are being African American, having less than a high school degree, and net wealth represented by a set of categorical variables (≤ 1,000; 1,001 to 20,000; 20,001 to 200,000, 200,001 to 500,000, and above 5000,000 as reference). The health insurance indicators are Medicaid coverage and having long-term care insurance. Living arrangements are controlled for by whether the person resides in a senior housing or a retirement community and whether any child lives within 10 miles. These two variables can also be considered as indicators of the availability of paid and informal home care.

The geographic variables are urban and suburban indicators. Time fixed effects adjust for changes in the long-term care market in the 1990s, such as the changes in Medicare home health reimbursement and the expansion in Medicaid home and community-based services. The error term (ε_{it}) captures any remaining unobserved heterogeneity.

Endogeneity

Two variables of interest may be endogenous to the participation in the long-term care market: proximity to death and residing with an adult child. Some argue that using long-term care may lengthen life. Holding other characteristics constant, nursing home residents may live longer than the elderly living at home because they benefit from closer supervision. Yet the opposite may apply: once institutionalized, the elderly persons may give up on life and die faster than if they were maintained in the community. Furthermore, unobserved individual characteristics may influence both proximity to death and long-term care use. For example, having a healthy life style—e.g., exercising and having a balanced diet—may not only lengthen life but also reduce the use of health care services. Zweifel and colleagues (2004) have tried to address the endogeneity of time to death in a model of health care expenditures [3]. They use lagged health care expenditures as quasi-instrumental variables, by controlling for them in their main equations. Their finding, that proximity to death, rather than age, is the main determinant of health care expenditures, is robust to endogeneity error. Yet, the authors point out that their instruments are likely to be invalid because they are correlated with unmeasured characteristics.

In the present study, no valid instrumental variables were found for proximity to death. Furthermore, *nonlinear* individual fixed effect models, that would account for part of the endogeneity, cannot be estimated because the probabilities of institutionalization and formal home care use are low [19, 31]]. However, we estimated linear probability models with and without individual fixed effects (FE) to observe the impact of adjusting for time-invariant unobserved heterogeneity. The coefficients on proximity to death are larger when adjusting for individual FE. These results (available on request) indicate that not adjusting for such heterogeneity provides conservative estimates because the coefficients of interest are smaller than they would be if we could take full advantage of the panel data. However, such linear probability models largely predict out of the [0,1] range and produce biased estimates [19].

The second variable of interest that is endogenous to long-term care use is co-residence with an adult child. An adult child may move in with a parent whose health is deteriorating to provide help with everyday needs. In that context, decisions about co-residence and long-term care use are made jointly. Furthermore, unobserved individual and family characteristics may affect both living and care arrangements. For example, the sense of responsibility and duties toward the elderly may vary across cultural or ethnic groups. Unobserved attitudes and beliefs not only affect the likelihood of a child living with an aging parent, but also the type of long-term care received by that parent. An instrumental variable strategy is adopted to correct for the endogeneity of co-residing with an adult child.

Some of the control variables, such as Medicaid coverage or residing in a retirement community, may also be endogenous to the long-term care decisions. We include them on our models to reduce the potential for omitted variable bias.

Estimation strategy

Because residing with an adult child is interacted with proximity to death, three equations are estimated simultaneously: the likelihood of institutionalization or the likelihood of formal home care use ($\Pr[Y_{it}=1]$), the likelihood of co-residing with an adult child ($\Pr[RCHILD_{it}]$), and the likelihood of co-residing with an adult child interacted with proximity to death ($\Pr[PTD_{it}\times RCHILD_{it}]$). We estimate a multivariate probit model by the method of simulated maximum likelihood. Non-concavities and non-convergence are common issues when estimating a multivariate probit model. Following Cappellari and Jenkins (2006), we experimented with different starting values and convergence algorithms to achieve stable results [32].

For identification purposes, we need a sufficient number of instrumental variables that predict co-residence with an adult child and its interaction with proximity to death, but do not predict the participation in the long-term care market. We use instruments similar to those found in the literature on informal home care: characteristics of the children of the elderly participants [33, 13-14]. It is well known that daughters are more likely to be caregivers than sons, and birth order may also matter. We therefore use the number of daughters and whether the oldest child is a daughter as instrumental variables. The number of grandchildren may also affect co-residence with an adult child, either because of competing demands on adult children or as a measure of family values and

communality. The age of the oldest adult child is also used to predict co-residence because it may capture the ability to co-reside with a frail parent. According to Wooldridge (2002), an endogenous variable appearing in an interaction term comes with its own instruments, which are the instruments for the endogenous variable (here the instruments for co-residence with an adult child) interacted with the other variable entering in the interaction (here proximity to death) [34].

For each type of care, we report both the standard single-equation probit model and the multivariate probit model to illustrate the impact of adjusting for the endogeneity of co-residing with an adult child on the estimates of interest. Standard errors are adjusted for heteroskedasticity and individual level clustering. The magnitude and significance level of proximity to death by sub-group is difficult to determine directly from the coefficients because we estimate nonlinear models with multiple interaction terms [35-36]. Thus, we rely on the bootstrap technique to determine the statistical significance and the marginal effect of proximity to death.

Finally, we test the robustness of our results to the measure of proximity to death, by running the same models using a shorter time to death indicator of 'being within *one* year of death' instead of 'being within two years of death'.

Data

The analysis is conducted on panel data from the Health and Retirement Study (HRS) from 1993 to 2002. In the present study, two cohorts of participants are used. The Asset and Health Dynamics Among the Oldest-Old (AHEAD) sampled people aged 70+,

and their spouses and partners, in 1993. This cohort was surveyed separately from 1993 to 1998 when it was merged with the HRS. The Children of the Depression (CODA) cohort was added to the HRS in 1998 and includes participants born between 1924 and 1930. The baseline samples are restricted to elderly living in the community, but the residential status of the respondents is not a criterion in subsequent waves. Because the baseline samples do not include institutionalized elderly, they represent a healthier group than the overall elderly population.

Our sample includes the participants aged 70 and over at baseline: it corresponds to 7,443 AHEAD participants in 1993 and 1,553 CODA participants in 1998. The spouses or partners younger than 70 are excluded from the analysis because long-term care use tends to occur at advanced ages [15]. The attrition over time is mainly due to mortality. Between two consecutive waves, the hazard rate of death varies between 10.6 and 16.6 percent for the AHEAD cohort and between 4.2 and 6.5 percent for the younger CODA cohort. Missing data, primarily on co-residence with adult children, results in dropping 7.3 percent of the observations. The regression analysis is conducted on four waves of data (1993, 1995, 1998 and 2000), while the 2002 observations help determine whether the persons surveyed in 2000 die within two years. The final sample has 23,534 observations and is used to estimate the model of the likelihood of nursing home use. Some 3.6 percent of these observations correspond to institutionalized participants at the time of the interview, leaving a community-based sample of 22,684 observations for estimation of the formal home care model. This community sample includes persons living in assisted living or senior housing facilities.

The participants are on average 78.8 years old with the youngest person being 70 and the oldest 107 years old. About 75 percent of the person-wave observations do not have any difficulties with IADLs and 76 percent with any ADLs. The most disabled persons, who report 4 to 5 ADL limitations, represent 5.5 percent of the observations. Low cognition is more prevalent at 15.1 percent. Males account for 39.4 percent of the observations, African American for 12 percent, and nearly 43 percent did not graduate from high school. The mean net wealth is $165,230, for a median of $80,500. Medicaid covers about 10.3 percent of the sample at some point, and the same proportion has long-term care insurance. About 6 percent of the sample lives in a retirement community or senior housing, and more than half has children living within 10 miles at some point during the survey. Urban and suburban residents represent 45 and 29 percent, respectively.

The persons approaching death are more likely to use long-term care than those further away from death (Table 1). Some 14.6 percent of the persons in their two last years of life reside in institution, compared to 2 percent of the people further away from death. Similarly, 14.7 percent of community residents within two years of death use formal home care, compared to 3.9 percent of those further away from death. Availability of informal care also differs by proximity to death. Married elderly account for 39.5 percent of the persons in their last two years of life while they represent 48.8 percent of the persons not close to death. Some 19.9 percent of the persons in their last two years of life reside with an adult child at some point, compared to 15.9 percent of those away from

death. As expected, these proportions are higher when considering the community dwellers only.

Results

Specification tests on instrumental variables

Table 2 provides results from specification tests. The set of instruments that performs the best in the nursing home model are the number of daughters, the number of grandchildren, the age of the oldest child, and whether the oldest child is a daughter interacted with proximity to death. In the formal home care model, the valid instruments are the number of grandchildren, whether the oldest child is a daughter and their interaction with proximity to death. The χ^2 tests indicate that for both types of care, the identifying instruments are strong predictors of co-residence with an adult child and its interaction with proximity to death. Over-identification tests, consisting of Wald tests on the instruments when included in the main equations, show that the instruments are also validly excluded from the main equations. Finally, the Rivers-Vuong exogeneity tests detect that residing with an adult child is endogenous to formal home care use but is exogenous to nursing home use [37]. Because the decisions to co-reside with an adult child and use long-term care are theoretically made simultaneously, we account for this endogeneity by using the multivariate probit models to determine the marginal effect of proximity to death.

Empirical models

Adjusting for the simultaneity of the living and care arrangement decisions has a limited effect empirically: the significance levels and magnitude of the coefficients of interest are comparable in the single-equation probit and multivariate probit models (Table 3). As expected, the simultaneity adjustment has the largest effect on the coefficients of the two endogeneous variables: co-residing with an adult child and its interaction with proximity to death. In both the nursing home and formal home care models, the variables of interest have the expected sign: positive on proximity to death and negative on being married, co-residing with an adult child (see Table 3).

The likelihood of institutionalization significantly increases with age but at a decreasing rate, as indicated by the positive coefficient on age and the negative coefficient on age squared. Age has a similar effect on the likelihood of formal home care use, as age and age squared are jointly significant ($\chi^2(2) = 34.33$, $p < 0.01$). As expected, the more disabled the person, the higher the probabilities of having any nursing home stay or any use of formal home care. Low cognition significantly increases the likelihood of institutionalization, but not formal home care use. Being a male, having low wealth, and being covered by Medicaid significantly increase the probability of being institutionalized, while being African American, low education, or living in a retirement community significantly reduce this probability. The effects of some of these variables differ in the formal home care model. The probability is lower if the person is male, has low wealth, or resides in a suburban area. The probability is higher if the person is covered by Medicaid or resides in a retirement community.

Overall effects of proximity to death and age

As mentioned previously, we bootstrap the multivariate probit models to predict the marginal effect of proximity to death and get consistent estimates of the standard errors. Overall, holding all characteristics constant (including marital status and co-residence with an adult child), being within two years of death significantly ($p<.01$) increases the probabilities of nursing home and formal home care use (Table 4). The marginal effect of proximity to death is larger for nursing home than formal home care, both in absolute terms (percentage point increase) and relative terms (percent increase). The likelihood of nursing home use is 4.0 percent not close to death and rises to 6.0 percent with proximity to death. This 2.0 percentage point increase means that the likelihood of institutionalization rises by 50 percent in the last two years of life. Among community–based elderly, the probability of formal home care use starts at 7.0 percent and goes up to nearly 7.9 percent in the last two years of life. Such an increase corresponds to a relative marginal effect of 12.4 percent.

In comparison, the marginal effect of age is smaller (Table 5). At age 80, the marginal effect of age on institutionalization is about 4.8 percent, and at age 90, it is 2.6 percent. The effect of age is smaller for formal home care use, with a relative marginal increase of 1.6 percent at age 80 and 1.1 percent at age 90. These results indicate that holding disability constant, both age and proximity to death impact the likelihood of long-term care use, but the effect of proximity to death is larger than the effect of age. It would take more than 10 years to get an effect of age similar to entering into the last two years of life.

Effect of proximity to death by sources of informal care

Table 6 reports that the probabilities of institutionalization and formal home care use are lower when informal support is available to the elderly (i.e., among married and co-residing individuals) than among non-married elderly. For example, non -married elderly are about five times more likely to be institutionalized than co-residing elderly, whether or not close to death. These results support the assumption of substitution between formal and informal care.

When focusing on the marginal effect of proximity to death we observe three phenomena (Table 6). First, as hypothesized, availability of informal care mitigates the effect of proximity to death. The largest effect is among non-married elderly: with proximity to death, the probability of nursing home use increases by nearly 75 percent and the probability of formal home care use by 15 percent. As indicated by the absence of overlap in the 95 percent confidence intervals, the marginal effects of proximity to death significantly differ between non-married elderly and married or co-residing elderly.

Second, proximity to death does not increase significantly nursing home use among married elderly. Proximity to death is significant among non-married and co-residing elderly for both types of care, and also among married elderly for formal home care. Third, co-residing with an adult child results in larger marginal effects of proximity to death than among married elderly, but these effects are significantly different for nursing home use only. Proximity to death increases significantly the likelihood of institutionalization if the elderly co-reside with an adult child while, as noted above there is no increase among married elderly. The effect of proximity to death on formal home

care use does not differ significantly by sources of informal care, with an increase ranging from nearly 9 percent among married elderly to 11.3 percent among co-residing elderly.

Robustness of results to measure of proximity to death

In the results presented above, proximity to death is defined as 'being within two years of death'. To observe whether our results are sensitive to this measure, we run the same models using a shorter indicator of time to death, i.e., 'being within *one* year of death', and its interaction with being married and co-residing with an adult child. Both measures of proximity to death provide comparable results, with modest differences described below.

In the nursing home model, availability of informal care has a larger mitigating effect for persons within one year of death than within two years of death. In the last year of life, the probability of institutionalization diminishes among married and co-residing elderly; in comparison, being within two years of death has no effect among married elderly and as a small positive effect among co-residing persons. In the formal home care model, the effect of being within one year of death is similar in magnitude to being within two years of death but is not significant. In addition, being within one year of death (compared to two years) has a larger positive effect for married and co-residing elderly. This sensitivity analysis does not raise any concerns on our main results, but suggests that proximity to death may have nonlinear effects in the last months of life.

Discussion

The results of this study have several methodological and policy implications. Both age and proximity to death are significant predictors of long-term care use. Formal long-term care use increases with age at a decreasing rate. Holding other characteristics of the elderly population constant, increasing longevity will raise to some extent the *per capita* demand for long-term care.

Another related implication is that the degradation in health attributable to mortality (captured by proximity to death) has a distinct effect from the morbidity process (measured by disability and cognition) and aging itself. The studies that disentangle the morbidity and mortality processes also find independent effects of these two dimensions [4-6, 11, 26]. However, because age is also a significant determinant of long-term care use, all three dimensions of health need to be considered to accurately estimate participation in the long-term care market.

This study is the first to document the interplay between two major determinants of long-term care use: proximity to death and sources of informal support. On one hand, proximity to death has a large positive effect among non-married elderly, who constitute the vast majority of the frail elderly population. On the other hand, proximity to death plays a smaller role for the elderly co-residing with an adult child, and even a smaller or non-significant role among married elderly. Such findings are important in the context of changing informal support. The ongoing increase in the proportion of married elderly (NCHS 2004) indicates that availability of spousal care increases among the 70+ population. Therefore, the role of proximity to death will lessen if spousal care continues

to become more prevalent. Even if spousal care substitutes for help from children, the role of proximity to death in shaping the demand for institutionalization will be reduced because proximity to death is not significant among married elderly, but is significant among individuals co-residing with adult children. More broadly, this study documents that changes in informal support interplay with health status and that the effect of health should not be considered separately from the effect of availability of informal care.

Limitations and future analyses

We measure proximity to death by a dichotomous indicator of being within two years of death to limit the number of interaction terms and address the endogeneity of co-residence with an adult child. Continuous indicators could help determine more specific patterns of long-term care use. Furthermore, proximity to death is likely to affect the quality, hours and expenditures devoted to long-term care, and such outcomes may also differ by types of informal support available to the elderly. In addition, it may be important to understand whether the interplays of proximity to death and sources of informal care differ by racial and ethnic groups because African Americans and Hispanics constitute an increasing proportion of the elderly population in the United States [38].

One unsolved methodological issue is the potential endogeneity of proximity to death [39]. However, as explained in the method section, our multivariate probit models provide conservative estimates: adjusting for individual fixed effects in linear probability models increased the magnitude of the coefficients of interest but did not change their significance level. Although, the endogeneity of proximity to death may be more

problematic for acute care than long-term care use, further efforts are needed to find valid instruments.

Increasing attention is being paid to the respective effects of aging and technology changes on health care expenditures [28, 40-41]. Beside age, proximity to death, and informal care, future works should also consider the effect of technology on long-term care use, even if technology improvements are much more limited in long-term care than acute care services.

Conclusions

Proximity to death is a major driver of the likelihood of long-term care use. Thus, measures of proximity to death need to be incorporated in models to accurately predict the demand for long-term care. As the likelihood of long-term care use does increase with age, increasing longevity alone will raise to some extent long-term care expenditures. Finally, the effect of proximity to death is significantly mitigated by availability of informal care. The participation in the long-term care market is not as concentrated at the end of life for married elderly or those co-residing with adult children as it is for non-married elderly.

Acknowledgements

Our thanks go to Frank Sloan, Willard Manning, Peter Kemper and Peggy Dilworth-Anderson for helpful comments during the course of this study. We also want to thank the participants at the inaugural ASHE conference in Madison and the Health Service Research Colloquium at The Pennsylvania State University, in particular Pamela

Farley Short. This research was funded by the Swiss Science Foundation, grant number PBSK1-106659. Additional support was provided by the Demography and Economics of Aging Research Group at The University of North Carolina at Chapel Hill, grant number NIA P30 AG024376.

References

1. National Center for Health Statistics (NCHS), *National Vital Statistics Report 2003*, accessed at http://www.cdc.gov/nchs/products/pubs/pubd/nvsr/nvsr.htm on October 2006

2. Zweifel P, Felder S, Meiers M. Aging of population and health care expenditures: a red herring?. *Health Econ* 1999; **8**: 485-496.

3. Zweifel P, Felder S, Werblow A. Population ageing and health care expenditure: new evidence on the "red herring". *The Geneva Papers on Risk and Insurance* 2004; **29**: 652-666.

4. Seshamani M, Gray A. Ageing and health-care expenditures: the red herring argument revisited. *Health Econ* 2004a; **13**: 303-14.

5. Seshamani M, Gray A. A longitudinal study of the effects of age and time to death on hospital costs. *J Health Econ* 2004b; **23**: 217-235.

6. Cutler DM, Meara E. The concentration of medical spending, an update. Wise DA ed, *Themes in the Economics of Aging*, The University of Chicago Press, Chicago, 2001; 217-240.

7. Felder S, Meier M, Schmitt H. Health care expenditures in the last months of life. *J Health Econ* 2000; **19**: 679-695.

8. Stearns SC, Norton EC. Time to include time to death? The future of health care expenditure Predictions. *Health Econ* 2004; **13**: 315-327.

9. Miller T. Increasing longevity and Medicare expenditures. *Demography* 2001; **38**: 215-226.

10. Yang Z, Norton EC, Stearns SC. Longevity and health care expenditures: the real reasons older people spend more. *J Gerontol Soc Sci* 2003; **58B**: S2-S10.

11. Cutler DM, Sheiner L. *Demographics and Medical Care Spending: Standard and Non-standard Effects*, NBER working paper 6866, 1998. Accessed at htpp:\\www.nber.org/papers/w6866.

12. Lo Sasso AT, Johnson RW. Does informal care from adult children reduce nursing home admissions for the elderly? *Inquiry* 2002; **39**: 279-297.

13. Van Houtven CH, Norton EC. Informal care and health care use of older adults. *J Health Econ* 2004; **23**: 1159-1180.

14. Charles KK, Sevak P. Can family caregiving substitute for nursing home care? *J Health Econ* 2005; **24**: 1174-90

15. Spector WD, Fleishman JA, Pezzin LE, Spillman BC. *The Characteristics of Long-term Care Users*. AHRQ publication No. 00-0049, 2000.

16. Spillman BC, Pezzin LE. Potential and active family caregivers: Changing networks and the "sandwich generation". *Milbank Q* 2000; **78**: 347-374.

17. Pezzin LE, Schone BS. Parental marital disruption and intergenerational transfers: an analysis of lone elderly parents and their children, *Demography* 1999; **36**: 287-297.

18. Carmichael F, Charles S. The opportunity costs of informal care: does gender matter? *J Health Econ* 2003; **22**: 781-803.

19. Bhattacharya J, Goldman D, McCaffrey D. Estimating probit models with self-selected treatments. *Statistics in Medicine* 2006; **25**: 389-413.

20. Spillman BC, Lubitz J. New estimates of lifetime nursing home use. Have patterns of use changed? *Med Care* 2002; 40: 965-975.

21. Spillman BC, Lubitz J. The effect of longevity on spending for acute and long-term care. *N Engl J Med* 2000; **342**: 1409-1415.

22. Lubitz J, Beebe J, Baker C. Longevity and Medicare expenditures. *N Engl J Med* 1995; 332: 999-1003.

23. Manton KG, Stallard E, Corder LS. The dynamics of dimensions of age-related disability 1982 to 1994 in the U.S. elderly population. *J Gerontol Biol Sci* 1998; **53A**: B59-B70.

24. Lakdawalla D, Goldman DP, Bhattacharya J, *et al.* Forecasting the nursing home population. *Med Care* 2003; **41**: 8-20.

25. Manton KG. Forecasting the nursing home population. *Med Care* 2003; **41**: 21-24.

26. Stearns SC, Norton EC, Yang Z. How age and disability affect long-term care expenditures in the United States. Draft submitted to *Social Policy and Society*. March 2006.

27. Lubitz J, Cai L, Kramarow E, Lentzner H. Health, Life expectancy, and health care spending among the elderly. *N Engl J Med* 2003; **349**: 1048-1055.

28. Dormont B, Grignon M, Huber H. Health expenditure growth: reassessing the threat of ageing. *Health Econ* 2006; **15**: 947-963.

29. Freedman V. Family structure and the risk of nursing home admission. *The Gerontologist* 1996; **51B**: S61-S69.

30. Newman SJ, Struyk R. Overwhelming odds: caregiving and the risk of institutionalization. *J Gerontol Soc Sci* 1990; **45**: S173-S183.

31. Greene WH. *Econometric Analysis*. 5th Ed. Prentice Hall, Pearson Education Inc. Upper Saddle River, 2003.

32. Cappellari L, Jenkins SP. Calculation of multivariate normal probabilities by simulation, with applications to maximum simulated likelihood estimation. *Stata J* 2006; **6**: 156-189.

33. Checkovich TJ, Stern S. Shared caregiving responsibilities of adult siblings with elderly parents. *Journal of Human Resources* 2002; **37**: 441-78.

34. Wooldridge JM. *Econometric Analysis of Cross Section and Panel Data*. The MIT Press: Cambridge MA. 2002.

35. Ai C, Norton EC. Interaction terms in logit and probit models. *Econ Lett* 2003; **80**: 123-129.

36. Norton EC, Wang H, Ai C. Computing interaction effects and standard errors in logit and probit models. *Stata J* 2004; **4**: 154–167.

37. Rivers D and Vuong QH. Limited information estimators and exogeneity tests for simultaneous probit models. *J Econometrics* 1988; **39**: 347-366.

38. Administration on Aging (AoA), U.S. Department of Health and Human Services (2003), "Facts and figures" statistics on minority aging in the U.S." accessed at http://www.aoa.gov/prof/statistics/minority_aging/facts_minority_aging.asp on 09/15/2003.

39. Salas C and Raftery J. Econometrice issues in testing the age neutrality of health care expenditures. *Health Econ* 2001; **10**: 669-671.

40. Cutler DM. The potential for cost savings in Medicare's future. *Health Affairs*, Web Exclusive, September 26, 2005. Accessed at http://content.healthaffairs.org.

41. OECD. *Projecting OECD health and long-term care expenditures: what are the main drivers?* Economics Department Working Papers, 2006.

Tables

TABLE 1. DISTRIBUTION OF VARIABLES OF INTEREST BY PROXIMITY TO DEATH

	Entire sample (N=23,534)		**Community-based sample** (N=22,684)	
	Within two years of death (N=2,914)	**Not in two years of death** (N=20,620)	**Within two years of death** (N=2,487)	**Not in two years of death** (N=20,197)
Institutionalized	427 (14.65) [(a)]	423 (2.05)	--	--
Home care user	--	--	366 (14.72)	794 (3.93)
Married	1,151 (39.50)	10,062 (48.80)	1,118 (44.95)	10,015 (49.59)
Reside with child	580 (19.90)	3,281 (15.91)	545 (21.91)	3,254 (16.11)

(a) The percentages are based on the number of observations in each column.

TABLE 2. SPECIFICATION TESTS ON INSTRUMENTAL VARIABLES

Model	**Strength of instruments**		**Overidentification test[(c)]**	**Exogeneity test**
	$RCHILD_{it}$	$PTD_{it} \times RCHILD_{it}$		
Formal home care[(a)]	$\chi^2(4) = 371.47$***	$\chi^2(4) = 704.18$***	$\chi^2(4) = 6.64$	$\chi^2(2) = 8.69$**
Nursing home[(b)]	$\chi^2(4) = 146.77$***	$\chi^2(4) = 3326.42$***	$\chi^2(4) = 3.20$	$\chi^2(2) = 3.39$

Valid instruments: (a) number of daughters, number of grand-children, age of oldest child and whether the oldest child is a daughter interacted with proximity to death. (b) Number of grand-children, whether oldest child is a daughter, and their interaction with proximity to death. (c) Wald test on instruments when included in main model. Significant ***at 1%, ** at 5%.

TABLE 3. NON-LINEAR MODELS

Variables	Nursing home use (N=23,534)		Formal home care use[(a)] (N=22,684)	
	Single Probit	**Multivariate Probit[(b)]**	**Single Probit**	**Mulitvariate Probit[(b)]**
Variables of interest				
Die in 2 years	0.510***	0.5252***	0.191***	0.2191***
	(0.057)	(0.638)	(0.067)	(0.0739)
Married × die in 2 years	-0.488***	-0.4924***	-0.081	-0.0992
	(0.136)	(0.1149)	(0.101)	(0.1095)
Res. child × die in 2 years	-0.178	-0.2387	-0.010	-0.0560
	(0.157)	(0.1905)	(0.115)	(0.1399)
Married	-0.617***	-0.6304***	-0.328***	-0.3430***
	(0.083)	(0.0738)	(0.066)	(0.0618)
Resident child	-1.148***	-1.3330***	-0.409***	-0.5867**
	(0.118)	(0.3813)	(0.075)	(0.2409)
Age	0.198**	0.1866***	0.108)	0.0878
	(0.080)	(0.0677)	(0.067)	(0.0742)
Age squared	-0.001**	-0.0009**	-0.001	-0.0004
	(0.001)	(0.0004)	(0.000)	(0.0004)
Disability				
1 IADL	0.125	0.1330	1.107***	1.1092***
	(0.082)	(0.0862)	(0.068)	(0.7345)
2-3 IADLs	0.373***	0.3861***	1.547***	1.5543***
	(0.082)	(0.0857)	(0.073)	(0.0776)
4-5 IADLs	0.853***	0.8680***	1.886***	1.9062***
	(0.089)	(0.1048)	(0.093)	(0.0962)
1 ADL	0.159**	0.1600*	0.459***	0.4605***
	(0.077)	(0.0840)	(0.059)	(0.0360)
2-3 ADLs	0.365***	0.3610***	0.750***	0.7438***
	(0.078)	(0.0836)	(0.059)	(0.0559)
4-5 ADLs	0.668***	0.6580***	1.061***	1.0566***
	(0.084)	(0.0509)	(0.072	(0.0661)
Low cognition	0.732***	0.7385***	-0.055	-0.0422
	(0.063)	(0.0551)	(0.055)	(0.0617)
Other control variables				
Male	0.100*	0.0970**	-0.200***	-0.2010***
	(0.061)	(0.0436)	(0.056)	(0.0501)
African American	-0.331***	-0.3098***	-0.059	-0.0443
	(0.081)	(0.0967)	(0.068)	(0.0635)
Less than high school	-0.322***	-0.3105***	-0.087*	-0.0760
	(0.059)	(0.0615)	(0.052)	(0.0561)
Medicaid	0.284***	0.2790***	0.438***	0.4353***
	(0.063)	(0.0734)	(0.059)	(0.0553)
LTC insurance	0.042	0.0345	-0.036	-0.0427
	(0.101)	(0.0746)	(0.080)	(0.0657)

TABLE 3. NON-LINEAR MODELS, CONTINUED

Variables	Nursing home use (N=23,534)		Formal home care use[a] (N=22,684)	
	Single Probit	**Multivariate Probit[b]**	**Single Probit**	**Mulitvariate Probit[b]**
Wealth <=1,000	0.432***	0.4514***	-0.196*	-0.1735*
	(0.119)	(0.0912)	(0.103)	(0.0935)
Wealth 1,001-20,000	0.321***	0.3321***	-0.171*	-0.1577*
	(0.114)	(0.1151)	(0.097)	(0.0928)
Wealth 20,001-200,000	0.036	0.0431	-0.229***	-0.2223***
	(0.104)	(0.1155)	(0.085)	(0.0802)
Wealth 200,001-500,000	0.012	0.0129	-0.177**	-0.1774**
	(0.115)	(0.1500)	(0.090)	(0.0746)
Live in retir. community	-0.654***	-0.7003***	0.394***	0.3437***
	(0.135)	(0.1370)	(0.069)	(0.1010)
Child within 10 miles	0.074	0.0305*	-0.073	-0.0816**
	(0.052)	(0.0324)	(0.045)	(0.0409)
Urban residence	0.023	0.0370	-0.058	-0.0442
	(0.063)	(0.0464)	(0.054)	(0.0483)
Suburban residence	0.046	0.0534	-0.146**	-0.1350**
	(0.067)	(0.0657)	(0.060)	(0.0539)
1995	--[c]	--[c]	-0.061	-0.0586
			(0.053)	(0.0737)
1998	0.540***	0.5356***	0.121**	0.1208*
	(0.052)	(0.0747)	(0.052)	(0.0634)
2000	0.556***	0.5498***	0.059*	0.0613
	(0.057)	(0.0652)	(0.056)	(0.0596)
Constant	-12.510***	-11.9664***	-7.400***	-6.7883**
	(3.384)	(2.9000)	(2.770)	(3.0889)
Log Pseudo-likelihood	-1,816.91	-11,553.81	-2,521.49	-11,565.81
Wald chi2(29/30)	1,765.00	2,064.81	2,910.78	8,646.16
Correlation 21[d]		0.1160		0.1156
		(0.1825)		(0.1609)
Correlation 31[e]		0.1471		0.1557
		(0.2157)		(0.2016)
Pseudo R square	0.50	--	0.45	--

Standard errors are in parentheses. They are obtained by 500 bootstrap iterations.
Significant at *** 1%, ** 5%, * 10%.
(a) Formal home care model estimated among the elderly living in the community.
(b) Multivariate probit estimated by the Maximum Simulated Likelihood, using 10 pseudo-random draws per equation.
(c) At baseline in 1993, the survey participants were all residing in the community. To achieve convergence of the model, the reference wave for the nursing home model is set to 1993/1995.
(d) Correlation of the error terms of the main equation and the likelihood of co-residing with an adult child, after adjusting for the simultaneity of the outcomes.
(e) Correlation of the error terms of the main equation and the likelihood of co-residing with an adult child within two years of death after adjusting for the simultaneity of the outcomes.

TABLE 4. OVERALL EFFECT OF PROXIMITY TO DEATH

Type of care	Mean predicted probabilities[a, b]		Marginal effect of proximity to death	
	Do not die in two years	Die in two years	Percentage points	Relative increase
Nursing home	4.01	6.03	2.02***	50.37%
	[3.94, 4.09]	[6.01, 6.05]	[1.92, 2.12]	
Formal home care	7.01	7.88	0.87***	12.41%
	[6.98, 7.40]	[7.75, 8.01]	[0.71, 1.03]	

In brackets are the 95 percent confidence intervals based on 500 bootstrap iterations.
*** Marginal effect significant at 1%. (a) Point-in-time probabilities: any use at the time of interview. (b) The probabilities are predicted holding constant other participants' characteristics (including marital status and co-residence with an adult child) and are averaged over the entire sample.

TABLE 5. MARGINAL EFFECT OF AGE

Type of care	Mean predicted probabilities[a, b]		Marginal effect of age	
	Age	Age+1	Percentage points	Relative increase
Nursing home				
Age=80	4.18	4.38	0.20***	4.78%
	[4.11, 4.26]	[4.31, 4.46]	[0.20, 0.20]	
Age=90	6.07	6.23	0.16***	2.64%
	[6.04, 6.10]	[6.18, 6.27]	[0.14, 0.18]	
Formal home care				
Age=80	6.94	7.05	0.11***	1.59%
	[6.93, 6.95]	[7.04, 7.06]	[0.10, 0.12]	
Age=90	7.88	7.95	0.07***	1.14%
	[7.83, 7.92]	[7.90, 7.99]	[0.07, 0.07]	

In brackets are the 95 percent confidence intervals based on 500 bootstrap iterations. *** Marginal effect significant at 1%. (a) Point-in-time probabilities: any use at the time of interview. (b) The probabilities are predicted holding constant other participants' characteristics (including marital status and co-residence with an adult child) and are averaged over the entire sample.

TABLE 6. EFFECT OF PROXIMITY TO DEATH BY AVAILABILITY OF INFORMAL CARE

Type of care	Mean predicted probabilities[a, b]		Marginal effect of proximity to death	
	Do not die in two years	Die in two years	% points	Relative increase
Nursing home				
Non-married[c]	5.07	8.84	3.77***	74.36%
	[5.04, 5.11]	[8.78, 8.90]	[3.74, 3.80]	
Married[c]	2.42	2.47	0.05	2.07%
	[2.22, 2.62]	[2.40, 2.53]	[-0.21, 0.32]	
Reside w/child[c]	1.09	1.52	0.43***	39.45%
	[1.06, 1.11]	[1.45, 1.60]	[0.34, 0.52]	
Formal home care				
Non-married[c]	7.72	8.92	1.20***	15.54%
	[7.68, 7.76]	[8.87, 8.97]	[1.11, 1.29]	
Married[c]	5.94	6.47	0.53***	8.92%
	[5.91, 5.96]	[6.23, 6.71]	[0.27, 0.80]	
Reside w/child[c]	4.94	5.50	0.56***	11.34%
	[4.91, 4.97]	[5.28, 5.73]	[0.31, 0.82]	

In brackets are the 95 percent confidence intervals based on 500 bootstrap iterations. *** Marginal effect significant at 1%. (a) Point-in-time probabilities: any use at the time of interview. (b) The probabilities are predicted holding constant other participants' characteristics and are averaged over the entire sample. For example, when predicting by marital status, co-residence with an adult child is held constant, and vice versa. (c) Marital status and co-residence with an adult child are not mutually exclusive categories.