Time to Drop Time-To-Death? – Unraveling the Determinants of LTC Spending in the Netherlands

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Abstract

A better understanding of what drives long term care (LTC) expenditures is important for all countries with aging populations. We employ unique new data sources to analyze the determinants of LTC spending in the Netherlands. First, we use two-part models, to analyze institutional LTC and homecare expenditures for the *entire* 55+ population, conditioning not only on age, sex, time-to-death (TTD), but also on cause-of-death and co-residence status. These have profound effects. Those living alone, as well as those who deceased from diabetes, mental illness, stroke, diseases of the respiratory or digestive system have higher LTC expenditures, while a neoplasm death resulted in lower expenditures. Secondly, we examine homecare expenditures among a sample of non-institutionalized individuals conditioning, additionally, on morbidity and disability. Finally, we reconsider the roles of age and TTD, when controlling for the most important determinants of LTC use - morbidity, disability and co-residence - and illustrate their relevance for forecasting LTC expenditures. Our analysis reveals that TTD is not a predictor of homecare expenditures when disability is controlled for, while age and co-residence are. We therefore conclude that it is time to drop time-to-death from LTC expenditure models as it merely acts as a proxy for disability status.

1. Introduction

Long-term care (LTC) is provided when individuals experience disability and/or chronic disease and is often required until the end of life. Consequently, the majority of LTC is used by the middle-aged and elderly. In particular, the Dutch 55+ population accounted for 88% of public LTC expenditures on homecare, residential and nursing homes in 2005. Therefore, as a result of population aging, LTC expenditure growth in developed countries is expected to accelerate in the coming decades. Given the fast rising share of older individuals in the population and their high LTC use rates, improved understanding of the factors that determine LTC use and expenditure is of utmost importance in order to be able to accurately forecast the need for such services, and to develop adequate policies to alleviate the pressure caused by aging populations on healthcare budgets.

Given that health and LTC expenditures generally rise with age, there is no controversy about the fact that the expected growth in expenditures can to some extent be attributed to population aging (Yang *et al*., 2003; Pezzin *et al*., 1996; Comas-Herrera *et al.*, 2007; OECD, 2006). With the most rapid growth in elderly cohorts still ahead of us, it is important to clarify to what extent population aging will raise expenditures. Previous studies focused on age being a 'red herring' in predicting healthcare expenditures: not age per se but time-to-death (TTD), which coincides with getting older, is the real reason why older people spend more (see

Payne, 2007 for a review). This has led to more optimistic forecasts of expenditures because it means that population aging postpones the last (expensive) years of life to higher ages, resulting in a shift of expenditures, instead of extra life-years with additional expenditures (Werblow *et al*., 2007; Zweifel *et al*., 1999; 2004; Payne, 2007). Currently, some degree of consensus seems to have emerged that TTD and not age determines *curative healthcare* expenditures, whereas both are relevant in explaining *LTC* expenditures (Werblow *et al*., 2007; Yang *et al*., 2003; Comas-Herrera *et al*., 2007). These studies therefore advocate the inclusion of TTD when modeling curative healthcare and LTC expenditures. In this study, we reconsider the role of TTD for explaining and forecasting LTC expenditures. While its inclusion in expenditure modeling has clarified the consequences of population aging, it still does not adequately represent the real cause of spending, as it is not death itself that drives up the expenditures, but the morbidity/disability that precedes - and may eventually lead to - death, suggesting that TTD itself may also be a red herring (Dormont *et al*., 2006). Consequently, when examining the consequences of aging for the healthcare sector, inclusion of morbidity and disability information is crucial as substantial changes in its trends are expected (Manton *et al*., 2006). Their exclusion might lead to biased forecasts of future expenditures. Likewise, by not including disability and health information, TTD might act as a proxy for morbidity. Moreover, including TTD as a determinant violates one of the conditions for causal inference as the cause (TTD) should precede the effect (expenditures). Clearly, previous studies have included TTD for lack of better data on morbidity and disability. Given improved data availability, we are able to reconsider the importance of both TTD and age in modeling LTC expenditures.

The aim of this study is to further clarify if and to what extent aging populations will lead to increasing LTC expenditures. Access to population data on public homecare and elderly institutional LTC enables us to examine the determinants of those expenditures for the entire Dutch 55+ population. We first analyze public LTC expenditures conditional on age, sex, TTD, cause-of-death and co-residence. To our knowledge, the influence of the latter two on expenditures has not been reported in previous studies of the 'red herring' hypothesis. Cause-of-death provides additional information on a group of intensive users – the decedents. With more reliable estimates of trends in disease prevalences becoming available, this will allow for better forecasts of LTC expenditures. Co-residence, like TTD, is associated with older age and higher expenditures. Its inclusion is important because it acts as a proxy for informal care availability (Sundström, 1994). Informal care is a potential substitute for homecare and may help to postpone an admission to a LTC institution (Van Houtven and Norton, 2004; Bonsang, 2009). We consider total LTC expenditures, as well as institutional and homecare expenditures separately. Next, for a representative sample of the non-institutionalized population, we are able to further examine the determinants of homecare expenditures by conditioning, in addition, on morbidity and disability. We focus on the role of TTD and age after control for co-residence, cause-of-death, morbidity and disability. Because both TTD and age act as proxies for morbidity and disability when data on the latter are lacking, TTD and age are expected to become redundant in explaining expenditures. Consequently, our study contributes to existing knowledge in a fourfold manner: (1) We first examine the effects of age, TTD, cause-of-death and co-residence on LTC expenditures for the entire Dutch 55+ population; (2) Adding morbidity and disability information for a representative sample of the non-institutionalized population allows for a more complete analysis of homecare expenditures; (3) Next, we reconsider the role of age and TTD in modeling LTC expenditures by evaluating their effects after controlling for the foremost prerequisites of access to public LTC; (4) Finally, forecasts of LTC expenditures based on trends in demographics, co-residence and disability illustrate the usefulness of our models, in particular, by showing the bias associated with using TTD as sole proxy for disability/morbidity when data on the latter are lacking.

2. Demand for public LTC in the Netherlands

In this paper, LTC is defined as publicly financed institutional LTC or homecare received as benefits-in-kind. Institutional LTC includes (temporary) admissions to residential or nursing homes. Residential homes provide living assistance only, whereas nursing homes also provide personal and nursing care. Homecare services include domestic help, domestic care, personal care and nursing care. Our data lack information on the LTC alternatives informal care, private care, and publicly financed LTC by a personal care budget (PCB). Informal care is crudely incorporated in the model by a proxy for informal care availability. PCB-financed LTC expenditures account for 5-10% of public homecare expenditures (Ministry of Health Welfare and Sports 2005). Finally, private provision only constitutes a relevant alternative for homecare; 1.4% of the 30+ population and 13.5% of the LTC users consumed private homecare in 2003 (Jonker *et al*., 2007). Overall, our models include the majority of LTC use.

All Dutch citizens are entitled to publicly financed LTC currently covered under the Exceptional Medical Expenses Act and the Social Support Act.[1] To reach a desired allocation of public resources, an assessment agency has been established to regulate access to public services by performing objective, independent and comprehensive assessments. Guidelines have been developed to structure this process. These guidelines are based on the International Classification of Functioning, Disability and Health (ICF; WHO 2001). Next to functioning, disability and health, ICF takes into account contextual factors. Hence, eligibility of individuals also depends on

[1] The Social Support Act is implemented in 2006. With its implementation, coverage of domestic care and domestic help has shifted from the Exceptional Medical Expenses Act to the Social Support Act and access to these services is currently regulated by local governments

their living situation and informal care availability (Peeters and Francke, 2007; Van Gameren and Woittiez, 2005). Public LTC is not entirely for free and users are charged an income-related copayment. It should be noted that while the institutional alternatives are mutually exclusive, the different homecare services are not and the decision to use either one of them or both is determined simultaneously (Van Houtven and Norton, 2004). Once considered eligible, individuals choose whether to receive this as a benefit-in-kind or as a PCB. PCB-holders can purchase informal care, formal care or a combination of both.

3. Methods

We first analyze total LTC, institutional LTC and homecare expenditures among the entire Dutch 55+ population, conditional on age, sex, TTD, cause-of-death, and co-residence. Next, we examine homecare expenditures among a representative sample of the non-institutionalized 55+ population, conditioning additionally on morbidity and disability. In the remainder of this paper we will refer to these distinct models as the 'population models' and the 'extended homecare model'.

3.1 Data

Population model

Three data sources linked at the individual level are used: the Registration of the Administrative Office Exceptional Medical Expenses 2004, Death

Causes Registration 2004-2007 and the Municipality Register 1998-2006. These data sources are country wide registrations registering, respectively, use and amount of public LTC services, time and cause-of-death, and several household and individual characteristics. Death causes are classified according to the 10th version of the International Classification of Diseases. We select all citizens aged 55 to 90 who survived until the end of 2004 and with complete information on co-residence status (before institutionalization, in the case of institutionalized individuals). Less than 0.4%, those who had moved into an institution before 1998, had incomplete information on co-residence status.

Extended homecare model

The General Survey of Living Conditions (POLS), which includes a detailed Health Survey, is also linked to the datasets described above. The POLS is an annual cross-sectional survey measuring the living situation of a representative sample of the independently living Dutch population.

We selected individuals covered by the Health Surveys of 2004/5 who survived until the end of the respective survey year and have not used additional inpatient LTC. The first criterion ensures that only individuals are selected for whom expenditures of an entire year could be observed. The latter excludes respondents who might have substituted homecare by institutional care. POLS respondents were sampled from the local government registrations in two stages. First, local governments, proportional to their size, were selected. Secondly, individuals were selected. 63% of individuals originally sampled for the Health Survey agreed to participate, of which 5534 individuals are aged 55+. Item non-response further reduced the sample to 4139. We refer to this as the Health Survey sample.

A comparison of the Health Survey sample with the entire non-institutionalized 55+ population showed that the former was healthier. Horvitz-Thompson weights based on age, sex, co-residence and TTD were derived to correct for this selection (Horvitz and Thompson, 1952). We use the resulting weights in all analyses presented here.

Dependent variables

Total public LTC expenditures consist of the sum of institutional LTC and homecare expenditures. Prices of admission days in a residential and nursing home as estimated in Oostenbrink *et al*. (2004) are used. We used recent approximations of the amount of use of somatic, psycho-geriatric and mixed wards and their relative price differences to estimate separate cost prices for these three different types of nursing home use. Maximum hour tariffs per homecare service for 2004, which are set by the Dutch Care Authority, were used as unit prices to estimate yearly homecare expenditures.

Selection of determinants

The Dutch institutional context and findings of previous studies determined the selection of covariates. TTD is controlled for by an indicator of whether the individual is still alive after 3 years, and a continuous variable measuring TTD in months (censored at 36 for survivors) and its square. Besides demographic characteristics, informal care availability, morbidity and disability status should undoubtedly have a strong association with use because they are explicitly taken into account by the assessment agency. Informal care availability is proxied by co-residence status. This is measured at the beginning of 2004 for individuals living in private households and at the month preceding institutionalization, for institutionalized individuals. Findings of previous studies support the inclusion of interactions between age, sex and TTD and TTD and co-residence (Werblow *et al*., 2007; Weaver *et al*., 2008). We also included interactions between co-residence and age/sex. Informal care availability might have a different effect on LTC expenditures for males and females due to differences in opportunity costs and ability to provide adequate care. Finally, the effect of co-residence might decrease with age as elderly become less able to provide adequate care. Cause-of-death is the only morbidity information available for the entire 55+ population. We categorize cause-of-death based on prevalence: neoplasm, diabetes, mental disease (predominantly Alzheimer’s disease), cardiovascular disease (CVD), diseases of the respiratory system, diseases of the digestive system, and other. We further split up CVD in cardiovascular accident (CVA) and other CVD because CVA is associated with a higher burden of disability. The reference category includes individuals who died from an external cause-of-death.

A much broader range of morbidity and disability indicators is available for the Health Survey sample. We selected the following morbidity indicators: self-reported health, mental health, having a chronic condition, and previous hospitalizations. Disability is measured by activities of daily living (ADL; Katz *et al*., 1963), mobility, and being limited in daily activities by chronic conditions. Regarding ADL and mobility items, respondents could answer whether they were able to perform an item without difficulty, some difficulty, much difficulty, or not able to perform (independently). Respondents who could not perform at least one activity independently were considered severely disabled. Respondent were considered moderately disabled if they could perform all items independently but at least one item with much difficulty. Respondents were considered mildly disabled if they could perform all items independently and without much difficulty but at least one item with some difficulty. Since the income-related copayments for public care might drive higher incomes to consume private care, we selected education and equivalent household income as measures of socio-economic status. Data availability restricted the follow-up of TTD in the Health Survey sample to 2 instead of 3 years. Furthermore, due to the smaller sample size, we have not considered cause-of-death. All covariates apart from TTD, age, sex, co-residence and income were self-reported. For a description of the covariates, see appendix A.

3.2 Model specification

We analyze yearly LTC expenditures as a function of personal characteristics. A two-part model (Jones, 2000) is used in order to account for the high proportion of respondents with zero expenditures (86%). This model analyzes behavior in two stages: the decision to use homecare (I) and the level of expenditures conditional on having any (II). Part I is a probit model for the probability of using LTC (i.e. having positive expenditures):

$$P(LTCE_{ij} > 0 | X_i) = \Phi(\beta_{1j} X_i), \tag{1}$$

for individual *i* and type of LTC *j,* with *j*=1 (total LTC, population), 2 (institutional LTC, population), 3 (homecare, population), 4 (total homecare, Health Survey sample). Φ represents the cumulative standard normal distribution, β_1 is a vector of parameters to be estimated and X_i represents a vector of covariates.

We followed the procedure proposed by Manning and Mullahy (2001) to select the most appropriate model for part II. The first step consists of assessing the presence of heteroskedasticity and skewness in the logged residuals from an ordinary least squares (OLS) regression model for the logarithm of expenditures (log OLS). We found skewness and heteroskedasticity in the logged residuals in all cases (j=1,…,4). This means that using log OLS, together with a homoskedastic smearing factor for retransformation back into raw scale, would lead to biased predictions of means and marginal effects. Alternatives are to use heteroskedastic smearing factors to retransform log OLS predictions, or to use generalized linear models (GLM), avoiding the retransformation problem altogether. We used a Box-Cox test and the Modified Park test to select, respectively, the link function and the family of GLM that best suits our data. The preferred GLM specification was one with power link and gamma family, for all types of expenditures. This specification also outperformed log OLS with heteroskedastic retransformation according to mean-squared errors and modified Hosmer-Lemeshow statistics. The preferred GLM model specifies the conditional mean expenditures as:

$$E(LTCE_{ij} \mid LTCE_{ij} > 0, X_i) = \sqrt[\lambda]{\beta_{2j} X_i + 1}, \qquad (2)$$

where β_2 is a vector of parameters to be estimated, and λ the Box-Cox transformation parameter. The conditional variance as a function of the mean is specified as:

$$V(LTCE_{ij} \mid LTCE_{ij} > 0, X_i) = E(LTCE_{ij} \mid LTCE_{ij} > 0, X_i)^2, \qquad (3)$$

i.e. the standard deviation is proportional to the mean.[2] The expected value of expenditures combines parts I and II in the following way:

$$E(LTCE_{ij} \mid X_i) = \Phi(\beta_{1j} X_i) * \sqrt[\lambda]{\beta_{2j} X_i + 1}, \tag{4}$$

where the first term on the right-hand side is the probability given by part I and the second term is the expected level of expenditures estimated by part II. We included the same covariates in part I and part II of the model, with one important exception: co-residence was excluded from part II for institutional LTC. We are interested in the effect of availability of informal care on the decision to institutionalize, but it should not influence the level of expenditures, once admitted.

4. Results

4.1 Descriptive statistics

Table I presents summary statistics for the entire 55+ population, and for subpopulations of institutional and homecare users, as well as those for the total Health Survey sample, and the subsample of homecare users. Of the population, 13.7% used LTC, 3.5% used institutional LTC and 11.4% used homecare. Average annual LTC expenditures were €1841, €1310 on

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[2] We have also considered an extended estimating equations model (Basu and Rathouz, 2005), which estimates the link and variance power function simultaneously. This yielded similar results to the chosen GLM specification.

institutional and €530 on homecare. 8% died within 3 years. Homecare users and – to a greater extent – institutional LTC users were older, more often female, living alone and closer to death than non-users. There is a large proportion of cancer deaths among non-users and homecare users, while deaths due to mental health and stroke are more prevalent among the institutionalized.

The last two columns describe the Health Survey sample. Homecare expenditures among users averaged €3861 per year. Compared to the entire sample, a larger proportion of homecare users is female, lives alone, is older, closer to death, has a lower socio-economic status, and reports a worse morbidity and disability status.

4.2 Results for population models

Appendix B presents estimates for the population models for total LTC, institutional LTC and homecare expenditures.[3] The majority of determinants and interactions have significant coefficients for both the probability of using and for the conditional level of LTC, institutional care and homecare expenditures. Interpretation of the probit and GLM coefficients is complicated by the nonlinearity of the models as well as the presence of many interaction terms (Ai and Norton, 2003). Therefore, we

[3] Due to the large standard error of the respective coefficient, which would result in large prediction errors, the interaction male*age^2 is omitted in part II of the model for institutional LTC.

interpret the effect of covariates by means of their average partial effects (APE) (table II; Wooldridge, 2004). We define the partial effect as the change in the predicted probability or conditional level of expenditures resulting from a one unit change in the explanatory variable. Partial effects are evaluated for each individual and then averaged across the population. We report the APE of a covariate for the whole population, as well as for some subgroups to demonstrate the effect of interactions. Standard errors are omitted because the results are obtained from population data.

Males have on average a 1.2 and 5.0 percentage point (pp) lower probability to use institutional LTC and homecare, respectively. On average, total LTC expenditures on males are €760 lower than on females. In all three models, age has a highly significant influence. A one year increase in age raises the average probability of using LTC, institutional LTC and homecare, respectively, by 1pp, 0.4pp and 0.8pp. Furthermore, a one year increase in age results in a €521 and €109 increase in conditional LTC and conditional homecare expenditures. The effect of age on institutional LTC expenditures among users is negative. This is most likely related to differences in cost prices and population characteristics of residential and nursing homes, with the latter having much higher costs but lower average age of its residents (Oostenbrink *et al*., 2004). However, the effect of age on expected expenditures is still positive for all three types of LTC. A 1 year increase in age has a larger effect on homecare and institutional care use in females and decedents. An exception is that the age-effect on the probability to use homecare is larger for female survivors than for female decedents. Older female decedents have probably more often substituted homecare by institutional care.

TTD turns out to be a major predictor of both institutional and homecare expenditures. Decedents have a 9.3pp higher probability to use LTC and cost on average €1840 more per year. A TTD of 1 month closer results on average in €216 higher yearly expenditures. TTD has a larger effect in females and those living alone. Female (male) decedents *co-residing* have on average €1781 (€883) higher expenditures compared to survivors while this is €3640 (€2444) for females (males) who *live alone*. All indicators for cause-of-death, apart from CVD, have a significant influence on the probability of use and conditional level of expenditures. Individuals deceased from a mental illness had substantially higher LTC expenditures than those who deceased from an external cause (+€21506), while those who deceased from a neoplasm have lower (-€3300) LTC expenditures. The effect of a mental illness cause-of-death is particularly large on institutional LTC expenditures. Mentally ill decedents are also less likely to use homecare as many demented patients need institutional care. The finding of lower expenditures for those deceased from a neoplasm may be related to their higher hospital expenditures (Wong *et al*., in press). All other death causes have a positive effect on LTC expenditures; individuals deceased from a disease of the respiratory system, CVA or diabetes cost on average €6296, €5818, and €5164 more compared to those deceased from an external cause.

In all models, co-residence status significantly influences both the probability to use and the conditional level of expenditures. Figure 1 shows the predicted expenditures by age, sex and co-residence. Living alone increases expenditures, but more so for males than for females. This heterogeneous effect of co-residence is likely to be caused by differences in opportunity costs and ability to provide care that could replace formal care. The effect of co-residence first increases with age but gradually decreases at older ages, suggesting that the ability to provide adequate care tends to decrease above a certain age. Females (males) aged 75+ living alone have a 13.8pp (22.1pp) higher probability to use LTC and cost yearly €822 (€2096) more compared to those co-residing.[4] The finding that co-residence appears to have a stronger effect on homecare expenditures than institutional LTC expenditures is in accordance with the result obtained by Bonsang (2009) that informal care is a closer substitute for the less skilled LTC services.

[4] Living alone has a negative effect on the conditional total LTC expenditures for individuals aged 75+. Because living alone increases conditional homecare expenditures for all ages, the negative effect derives only from the effect of co-residence on the conditional level of institutional LTC expenditures. It is plausible to assume that the institutionalized elderly who lived alone prior to their institutionalization are less disabled compared to co-residing elderly. Hence, not co-residence, but the associated difference in disability might cause the negative effect of living alone on conditional LTC expenditures for individuals aged 75+.

4.3 Results for extended homecare model

Table III presents the APE's of covariates on the probability and (conditional) level of homecare expenditures.[5] APE estimation was bootstrapped to obtain standard errors for statistical inference (Efron & Tibshirani, 1993). Both parts of the model for total homecare expenditures fit the data quite well (adjusted- R^2 of 38.3 for part I and a deviance of 394 for part II). Overall, most covariates affect homecare expenditures as expected. Even after including extensive information on morbidity and disability, age still shows a significant effect on both the probability of use and the level of homecare expenditures. The influence of age on homecare expenditures is larger for females than for males: a one year older female (male) cost on average €36 (€17) more, ceteris paribus. Next to age, the effect of disability on the probability to use is considerable while morbidity indicators, apart from previous hospitalizations, do not influence homecare use. ADL disability, mobility disability and a limitation in daily activities all increase the likelihood of using homecare. On average an additional €130 is spent on homecare for individuals mildly limited in daily activities compared to those not limited at all. Individuals who are moderately (severely) disabled in ADL cost on average €319 (€1754) more. The large effect of disability on using homecare is not so surprising given that disability is the foremost

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[5] Appendix C shows estimated coefficients.

prerequisite for obtaining access to publicly financed homecare. A second central eligibility criterion is the availability of informal care and this is reflected in the strong effect of co-residence on the likelihood to use homecare. As in the population model, the effect of co-residence is stronger for males than females. Males living alone cost on average €488 more than co-residing males, while females living alone cost only €216 more. Finally, income only has a significant influence on the probability to use homecare. As expected, individuals with higher incomes have a lower probability to use homecare. This confirms that the income-related copayments do provide an incentive for higher incomes to use less public and more private homecare.

4.4 Effect of age and TTD re-evaluated

Figure 2 evaluates the effect of age estimated in the population model when conditioning on additional determinants. The left, middle and right figure represent respectively the level of total LTC, institutional LTC and homecare expenditures. The Y-axis represents the additional expenditures of individuals aged 56-90 compared to individuals aged 55. The slope of the line thus represents the age-effect. The different lines in the figure evaluate the age-effect in: (1) a ‘naïve’ model analyzing expenditures as a function of age and sex only, (2) a red herring (RH) model, including TTD, (3) one adding cause-of-death, and (4) one adding co-residence. For all types of expenditures, the effect of age increases more rapidly at higher ages. The figures show that the effect of age on all types of LTC expenditures falls considerably, but remains significant, after control for TTD. This suggests that TTD could indeed partially explain the higher expenditures among the older aged. The inclusion of cause-of-death only marginally decreases the effect of age on expenditures. However, by controlling additionally for co-residence, the effect of age on homecare expenditures, and to a lesser extent institutional LTC expenditures, decreases but remains significant for all LTC services. When moving to the extended homecare model we are able to further examine the changes in the age-effect on homecare expenditures by controlling additionally on disability and morbidity (figure 3). As in the population model, by adding TTD to a naïve model, the age-effect clearly decreases but remains important. By contrast, controlling instead for disability substantially reduces the effect of age on the level of expenditures. Adding either TTD or morbidity to a model controlling for age, sex and disability, shows that neither of these further decreases the effect of age on the level of expenditures. Finally, further controlling for co-residence still has an important impact.

Figures 4-5 illustrate the TTD-effect in a similar way as the previous figures did for the age-effect. Figure 4 compares the TTD-effect in a RH model to those in models (1) controlling additionally for cause-of-death and (2) controlling additionally for co-residence, all estimated with the population model. The Y-axis represents additional predicted expenditures of decedents by TTD compared to those of survivors. For all types of expenditures, the TTD-effect increases more rapidly when moving closer to death. By moving from a RH model to one conditioning additionally on cause-of-death, we see a downward shift of the curve, i.e. the excess spending for decedents drops, but more so for institutional care than for homecare expenditures. By contrast, after controlling further for co-residence, the excess spending on decedents falls more for homecare than for total and institutional LTC. Figure 5 illustrates the additional changes in the TTD-effect on homecare expenditures estimated by the extended homecare model. Instead of controlling for cause-of-death, we condition on morbidity and disability measures, available for both decedents *and* survivors in the Health Survey. The consequences of adding disability to a RH model are striking: expenditure differences between decedents and survivors is reduced dramatically (i.e. the curve shifts downwards), but expenditures also hardly vary with TTD among decedents (i.e. the slope of the curve decreases considerably and even becomes insignificant). While the RH model predicts individuals in their last month of life to cost on average €1000 more compared to survivors, these same individuals cost on average only €300 more after controlling for disability. Controlling additionally for morbidity results in a further reduction of the TTD-effect, while further controlling for co-residence results in a small but insignificant increase of the TTD-effect.

4.5 Forecasts of LTC expenditures

Under the assumption that the associations we identified allow for a causal interpretation, we outline in this section some forecasts of LTC expenditures based on trends in demography, co-residence, and disability. When doing so, it is important to bear in mind that not only individual determinants, but also healthcare organizational features (e.g. the eligibility criteria, informal care availability, and waiting lists) co-determine utilization, and hence expenditures (Anderson & Newman 2005; Getzen, 2001). Using a naïve age-based model, by the year 2040 per capita LTC expenditures among the 55+ population are expected to increase by 50%; 53% for institutional LTC and 41% for homecare. Clearly, RH models, taking into account increases in life-expectancy, result in more optimistic forecasts: per capita expenditures are only expected to increase by 33% rather than 50%. With disability being the foremost prerequisite for access to public LTC, extrapolating recent declines in disability[6] (Perenboom *et al*., 2004; LaFortune et al., 2007), leads to 40% (7%) lower expected per capita homecare expenditures in 2040 compared to the naïve scenario (red herring scenario). This large variation in forecasts based on either mortality or disability trends highlights how misleading it can be to use TTD as a proxy for disability when forecasting LTC expenditures.

As the share of elderly living alone is expected to rise (OECD, 2005), this will lead to higher expenditures, *ceteris paribus*. The expected larger

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[6] 1.5% yearly decline in severe disability

increases in life expectancy for males (Statistics Netherlands 2009) will probably result in a larger proportion of single living males, and therefore higher homecare costs. Other trends that might contribute to a lower proportion of co-residing elderly are an individualization of society and increasing divorce rates. Compared to naïve forecasts, forecasts taking into account trends in co-residence result in 59% instead of 50% higher per capita LTC expenditures.

5. Discussion

We have examined the determinants of public LTC expenditures, including both institutional LTC and homecare, among the Dutch 55+ population. Our approach goes beyond earlier efforts in a number of respects. First, we model LTC expenditures using a nationwide dataset including virtually the entire Dutch 55+ population. Secondly, next to using information on the determinants usually included in LTC expenditure models, linkage to administrative micro data sources made it possible to examine the influence of cause-of-death and co-residence. Co-residence, a proxy for informal care availability, is shown to have a large influence on LTC expenditures while cause-of-death information provides additional insight into the expenditure variation among intensive users of LTC. Third, linkage to additional morbidity and disability information from a representative survey of the Dutch independently living population allowed us to further examine homecare expenditures.

Despite the fact that morbidity and disability are among the prime determinants of LTC use, to our knowledge no previous studies examining the impact of population aging on LTC expenditures have been able to include morbidity and disability information. This facilitated a re-examination of the importance of age and TTD for modeling expenditures and to gain further insight into the consequences of population aging on LTC expenditures. Although age and TTD are considered as key determinants of expenditures, neither of them are causes of expenditure in and of themselves, but serve as proxies for morbidity and disability, the real underlying drivers of LTC expenditures. We illustrated the usefulness of our models for improved projections of future LTC expenditures based on trends in demographics, co-residence and disability and demonstrated the bias introduced when TTD is used as a proxy for disability/morbidity when data on the latter are lacking.

Our main findings are as follows. First, and not surprisingly, both co-residence and cause-of-death are important determinants of LTC expenditures. Individuals living alone are substantially more likely to use LTC, especially homecare, and their level of expenditures is much higher than that of co-residing individuals. Also cause-of-death matters: individuals who die from diabetes, a mental illness, a stroke, a disease of the respiratory system or digestive system have significantly higher LTC expenditures compared to those deceased from an external cause. A death from a neoplasm, on the other hand, was associated with significantly *lower* LTC expenditures. The common covariates in red herring type models, such as age, sex and TTD, showed the expected effects. Secondly, the effects of some covariates displayed substantial heterogeneity, as they were found to depend crucially on the levels of other covariates. For example, males living alone have substantially higher expenditures compared to females living alone, especially for the oldest elderly. Also the effect of TTD varies considerably by co-residence and sex, with a larger effect of TTD on expenditures in females and those living alone. Third, the age-effect was shown to be confounded by TTD and co-residence status, but even more so by disability status. The age-effect decreased after controlling additionally for TTD and co-residence but the extended homecare model showed that both decreases are dwarfed by the decrease of the age-effect after controlling for disability, the foremost prerequisite for obtaining access to public LTC. Unfortunately we were only able to examine this for homecare and not for institutional LTC. In spite of the substantial drop after control for disability, the age-effect on homecare expenditures remains significant. Apart from age itself, self-reported disability and co-residence status are the two other important determinants of homecare expenditures in the Netherlands. The fact that age retains a significant impact on LTC utilization suggests that assessment agencies either take into account the age of the applicant regardless of their objective need for care or that disability is still incompletely controlled for. Finally, the excess LTC spending on decedents compared to survivors clearly diminishes after control for cause-of-death and co-residence in the population model, but remains significant. However, after further control for disability (in the extended homecare model), the effect of TTD becomes insignificant. This finding and the observation that expenditures in the last years of life vary considerably by cause-of-death both confirm that TTD is indeed nothing but a proxy for morbidity/disability. Finally, our model projections of expected future expenditures indicate that the growing share of single living elderly will result in 9pp higher per capita LTC expenditures in 2040 than a naïve model would estimate. Extrapolating current disability trends results in a 40pp lower growth of expenditures between 2004 and 2040 compared to naïve forecasts while using mortality trends and a RH model results in a lower growth of only 33pp.

Three points are worth noting regarding the use of co-residence in modeling and forecasting LTC expenditures. First, the relationship between co-residence, used here as a proxy for informal care availability, and expenditures is not likely to remain constant. We have shown that co-residents of females, usually males, are less willing/able to provide LTC which is probably due to the higher male labor force participation resulting in higher opportunity costs and males being less skilled in caring. That is why co-residence reduces LTC expenditures more for males than females. This heterogeneous effect of co-residence by sex is likely to converge in the future as a result of increased female labor participation and emancipation of males in household duties. Second, co-residence is only a crude proxy for informal care availability. While most informal care is provided within the household, there are other sources of informal care, which we could not take into account. Third, because our models - to a large extent - replicate the eligibility criteria used by the Dutch assessment agency, the influence of co-residence on LTC expenditures may be stronger in the Netherlands than elsewhere. However, our models do not merely reproduce the rules since the guidelines still leave room for discretionary decision making and personal judgment. Moreover, the decision to demand public LTC by contacting the agency instead of choosing other, private sources of LTC still remains with the individual and her social environment.

We believe we have shown that TTD is indeed an imperfect proxy for morbidity/disability that becomes redundant after appropriate control for the latter. This means that TTD itself can be regarded as a 'red herring' in LTC and raises doubts about its role in forecasting healthcare expenditures. Forecasts based on models including only TTD instead of disability implicitly assume that rising life expectancy merely shifts disability to older ages. As such, it does not allow for expectations about a compression (or expansion) of disability (Fries, 1980). Hence, in the case of a compression scenario, a RH model to forecast LTC expenditure would still overestimate the effect of population aging.

Unfortunately, we were only able to fully examine the relevance of TTD in modeling homecare expenditures as data on disability was not available for institutionalized individuals. Furthermore, the redundancy of TTD in modeling expenditures cannot necessarily be generalized to curative healthcare expenditures as previous studies found the effect of TTD to be much larger for curative than for LTC expenditures (Werblow *et al*., 2007; Yang *et al*., 2003). Because also these were unable to control for morbidity/disability it remains to be seen whether TTD is also redundant in estimating curative expenditures.

Concluding, while previous studies have claimed that not age but TTD drives LTC expenditures, we have shown that once controlling for disability, TTD itself is a red herring, while age itself, disability and informal care availability are important determinants of LTC expenditures. The finding that TTD is merely an imperfect indicator of disability status suggests that the time has come to drop TTD in modeling LTC expenditures and replace it with more appropriate indicators of care needs, like disability.

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Table I Description of population and Health Survey sample

	Dutch 55+ population (n=4039085)	Institutional users 55+ population (141233)	Homecare users 55+ population (462431)	55+ Sample Health Survey (n = 4139; weighted)	Users Sample Health Survey (n=384; weighted)
LTC Consumption					
LTC use (%)	13.7	100.0	100.0	10.2	100.0
LTC costs	1841 ± 9491	39492 ± 25251	7053 ± 14183	393 ± 2157	3861 ± 5692
Institutional use (%)	3.5	100.0	10.7	0	0
Institutional costs	1310 ± 8725	37473 ± 28669	2420 ± 10416	0	0
Homecare use (%)	11.4	35.0	100.0	10.2	100.0
Homecare costs	530 ± 3532	2019 ± 6728	4632 ± 9484	393 ± 2157	3861 ± 5692
Socio-demographics					
Age	67.1 ± 9.1	80.7 ± 7.0	76.7 ± 8.3	66.6 ± 8.7	75.9 ± 8.4
Male (%)	46.2	27.7	25.3	46.9	23.9
Alive[a] (%)	92.0	53.4	76.8	95.7	88.6
TTD in months if deceased	18.0± 10.5	15.7 ± 10.4	17.0 ± 10.6	12.0 ± 7.0	9.5 ± 7.2
Living alone (%)	26.7	62.4	61.0	25.3	62.0
Socio-economics					
Education (%)					
Low				42.7	59.0
Middle	-		-	37.8	32.9
High				19.6	8.1
Income	-		-	22469 ± 26007	20332 ± 60425
Health					
Cause-of-death/ICD (%)					
External cause-of-death	2.6	2.3	2.5		
Neoplasm	31.7	11.9	25.5		
Diabetes	2.7	3.7	3.4		
Mental	4.6	13.4	4.7		
CVD exclusive CVA	24.7	21.4	25.4		
CVA	7.6	11.2	8.3		
Respiratory disease	10.7	15.2	13.3		
Digestive system	4.0	4.2	4.4		
Other	11.5	16.8	12.5		
Self-reported health (%)					
(very) Good	-		-	63.9	31.0
Fair				29.2	47.7
(very) Poor				6.9	21.3
Chronic condition (%)	-		-	50.5	79.3
Hospitalization (%)	-		-	53.9	80.3
Mental Health Score	-		-	78.9 ± 15.8	71.6 ± 19.6
Disability					
Limited in daily activities conditional on having a chronic condition (%)					
Not limited				61.9	7.5
Mildly limited	-		-	17.2	22.5
Severely limited				20.9	70.1
ADL disability (%)					
Not disabled				80.8	45.0
Mildly disabled	-		-	14.6	30.5
Moderately disabled				2.9	13.2
Severely disabled				1.8	11.3
Mobility disability (%)					
Not disabled				71.7	28.0
Mildly disabled	-		-	16.9	24.8
Moderately disabled				7.9	27.5
Severely disabled				3.4	19.7

[a] Follow-up period alive is 3 (2) years for the entire 55+ population (Health Survey sample)

Table II Average Partial Effects of covariates on the likelihood of total LTC, institutional and homecare use and expenditures

Covariates	Total LTC			Institutional LTC			Homecare		
	Part I	Part II	Part I * II	Part I	Part II	Part I * II	Part I	Part II	Part I * II
Male	-0.059	-687	-760	-0.012	-680	-451	-0.050	-383	-235
Age (overall)	0.010	521	180	0.004	-120	125	0.008	109	41
Age in female survivors	0.013	481	192	0.004	76	135	0.010	100	52
Age in female decedents	0.018	1085	1056	0.017	-121	668	0.007	192	125
Age in male survivors	0.005	203	65	0.001	-310	47	0.004	63	18
Age in male decedents	0.015	259	368	0.009	-306	277	0.008	113	64
Alive (overall)	-0.093	-5059	-1840	-0.035	731	-1239	-0.087	-1492	-570
Alive in females co-residing	-0.107	-5795	-1781	-0.030	219	-1076	-0.110	-1526	-591
Alive in females living alone	-0.142	-5358	-3640	-0.071		-2457	-0.105	-1635	-1076
Alive in males co-residing	-0.050	-4033	-883	-0.019	2065	-681	-0.053	-1098	-240
Alive in males living alone	-0.126	-3451	-2444	-0.048		-1755	-0.125	-1246	-884
TTD (overall)	-0.005	-243	-216	-0.004	-108	-186	-0.003	-56	-33
TTD in females not living alone	-0.006	-199	-208	-0.004	-144	-182	-0.003	-46	-37
TTD in females living alone	-0.003	-319	-296	-0.005		-256	0.000	-72	-34
TTD in males not living alone	-0.006	-138	-160	-0.003	-33	-129	-0.005	-34	-29
TTD in males living alone	-0.005	-229	-214	-0.005		-199	-0.002	-57	-40
Cause-of-death (ref. group: external)									
Neoplasm	-0.030	-6836	-3300	-0.067	-4546	-2896	0.011	-1252	-339
Diabetes	0.137	4978	5164	0.081	3266	3767	0.087	2102	1349
Mental	0.234	27130	21506	0.296	23308	21903	-0.041	1824	248
CVD apart from CVA	0.007	-170	44	-0.012	1782	-143	0.018	77	135
CVA	0.071	9162	5818	0.080	9014	5207	0.014	1238	488
Disease respiratory system	0.139	6939	6296	0.088	8094	5338	0.080	1445	1036
Disease digestive system	0.053	3705	2726	0.022	7577	2304	0.037	427	372
Other	0.098	9828	6839	0.093	8850	5734	0.028	2179	908
Living alone (overall)	0.095	-1217	772	0.015	-	547	0.089	897	468
Living alone in females 55-74 years	0.070	278	488	0.008	-	292	0.067	908	311
Living alone in females 75+	0.138	-1760	822	0.029	-	962	0.133	671	859
Living alone in males 55-74 years	0.076	67	747	0.011	-	451	0.069	1422	315
Living alone in males 75+	0.221	-2141	2096	0.042	-	1424	0.203	1290	1182

Figure 1: Predicted LTC expenditures by age, sex and co-residence status

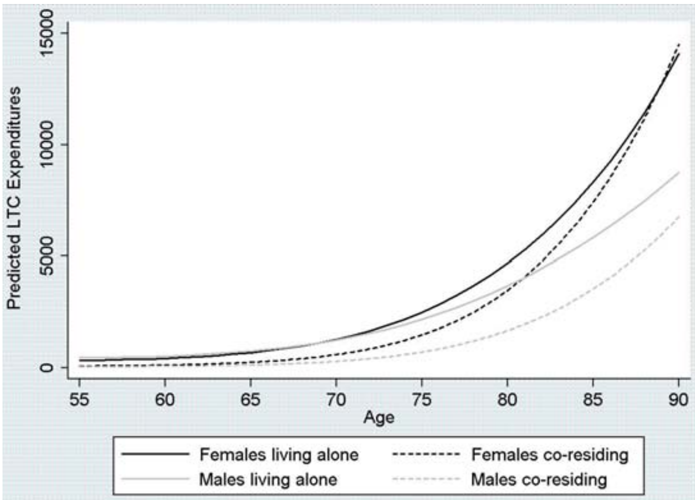

Figure 2: Additional total LTC (a), institutional LTC (b), and homecare (c) expenditures by age compared to a 55-year old (population model)

(a) (b) (c)

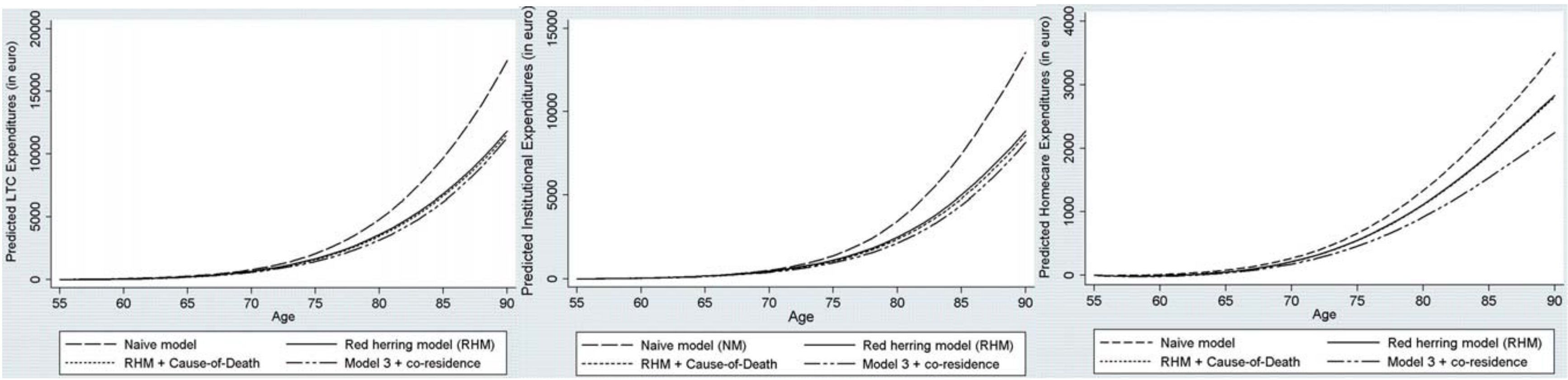

Figure 3: Additional homecare expenditures by age compared to a 55-year old (Health Survey Sample)

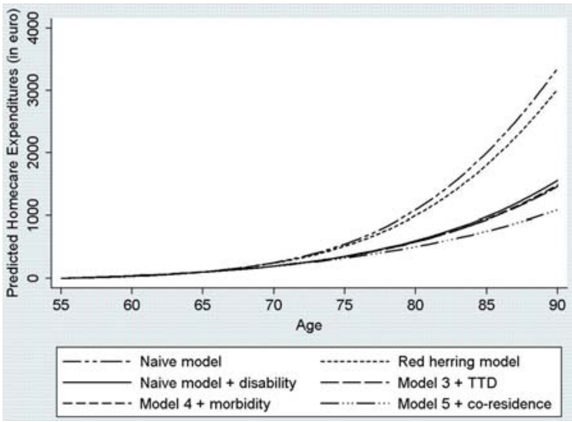

Figure 4: Additional total LTC (a), institutional LTC (b) and homecare (c) expenditures by TTD compared to a survivor (population model)

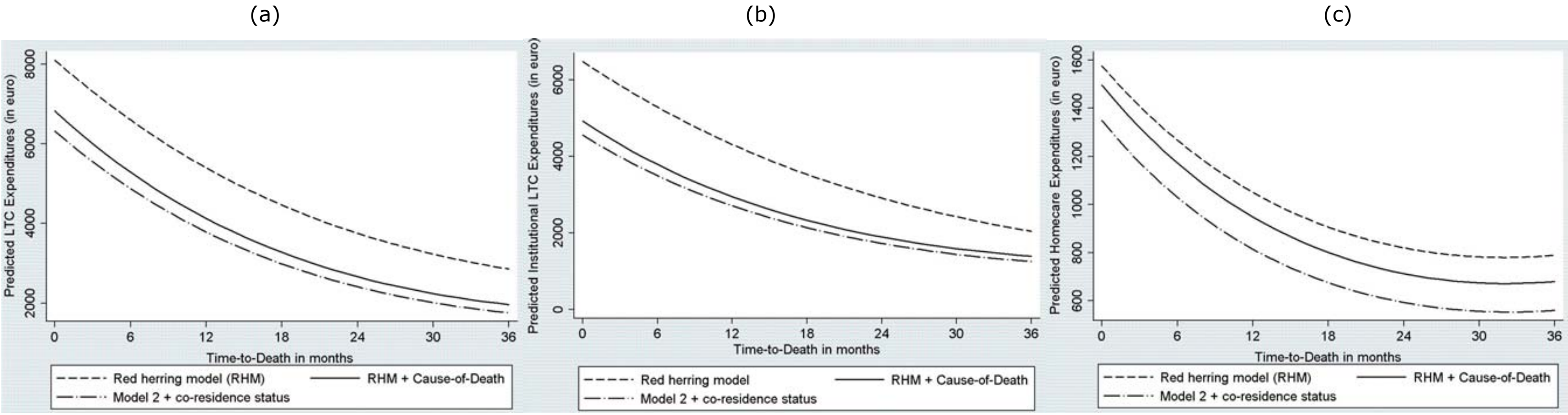

Figure 5: Additional homecare expenditures by TTD compared to survivors (Health Survey Sample)

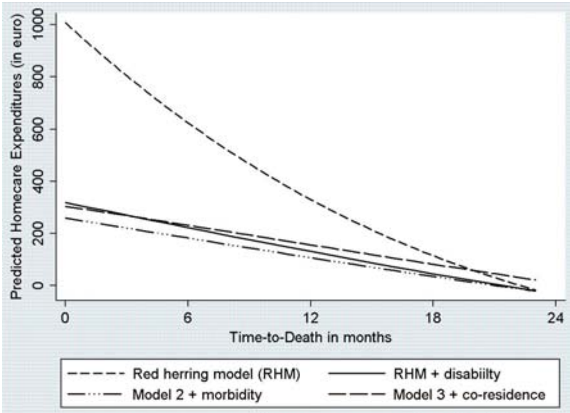

Table III Average partial effects for the probability to use (part I), the level of expenditures among users (part II) and the entire Health survey sample (part I * II)

Covariates	Homecare		
	Part I	Part II	Part I * II
Socio-demographic characteristics			
Age in females	0.008***	101*	36***
Age in males	0.004***	115*	17***
Male	-0.022*	321	-9
Alive after 2 years	0.048	-2394	-19
Time-to-death in months	-0.005	73	-31
Living alone in females	0.064***	261	216**
Living alone in males	0.115***	2374**	488***
Socio-economic characteristics			
Education middle	0.009	-541	-33
Education high	-0.021	308	-39
Income (x €1000)	-0.002**	-28	-9
Health status indicators			
Self-reported health - Good	0.012	-3235	-257
Self-reported health – Fair	0.022	-2316	-136
Self-reported health – (very) Poor	0.022	-2199	-126
Chronic condition	0.000	742	76
Mental health	-0.000	-5	-1
Previous hospitalization	0.046***	-543	87
Disability status indicators			
Limited in daily activities - mildly	0.038*	283	130*
Limited in daily activities - severely	0.059**	485	209
ADL – mildly disabled	0.015	580	91
ADL – moderately disabled	0.071*	1169	319*
ADL – severely disabled	0.108*	8527***	1754***
Mobility – mildly disabled	-0.006	-494	-59
Mobility – moderately disabled	0.049*	-271	104
Mobility – severely disabled	0.067*	40	191

Partial effect continuous variables: the effect of a one unit change in the covariate on the probability to use (part I), the conditional level of expenditures in users (part II) and the total level of expenditures for entire sample (part I * III)
Partial effect discrete and indicator variables: the effect of a change from 0 to 1 on the probability to use (part I), the conditional level of expenditures in users (part II) and total level of expenditures for the entire sample (part I * II). For indicator variables: partial effect with respect to the reference category
Standard errors to obtain significance levels obtained by bootstrapping.

Appendix A Description of covariates in population and extended homecare model

Covariate	Description	Model[c]
Male	Sex of respondent: 0 = female; 1 = male	P+E
Age	Age of respondent	P+E
Age^2	Age^2 of respondent	P+E
Age^3	Age^3 of respondent	P
Age*Male	Interaction age * male	P+E
Age^2*Male	Interaction age^2 * male	P
Alive[a]	Indicator TTD: 0 = not deceased ≤3 (2) year; 1 = deceased ≤3 (2) year	P+E
Time-to-death	Time-to-death in months; survivors are set to the maximum of 24	P+E
Time-to-death^2	Time-to-death in months^2; survivors are set to the maximum of 24	P
Living alone	0 = co-residing; 1 = living alone	P+E
Alive*male	Interaction alive * male; 1 = male alive; 0 = else	P
Time-to-death*male	Interaction TTD * male: 0 = female; else = TTD of males	P
Time-to-death^2* male	Interaction TTD^2 * male: 0 = female; else = TTD^2 of males	P
Alive*age	Interaction alive * age; 0 = deceased; else = age of survivors	P
Alive*living alone	Interaction alive * living alone; 1 = alive living alone; 0 = else	P
Time-to-death*living alone	Interaction TTD * living alone; 0 = not living alone; else = TTD of individuals living alone	P
Time-to-death^2*living alone	Interaction TTD^2 * living alone; 0 = not living alone; else = TTD^2 of individuals living alone	P
Living alone*male	Interaction male*living alone; 1 = male living alone; 0 = else	P+E
Living alone*age	Interaction living alone * age; 0 = not living alone; else = age of individuals living alone	P
Education	Highest educational level: 0 = low; 1 = middle; 2 = high	E
Income	Logarithm of monthly net equivalent household income = log(yearly household income/household members^0.5); information obtained from income production system	E
Cause-of-death	0 = external cause; 1 = neoplasm; 2 = diabetes; 3 = mental; 4 = CVD exclusive CVA; 5 = CVA; 6 = disease respiratory system; 7 = disease digestive system; 8 = other	P
Perceived health	Self-reported health: 0 = very good; 1 = good; 2 = fair; 3 =	E
Chronic condition	(very)poor	E
Hospitalization	Presence of chronic condition: 0 = no; 1 = yes	E
	Hospitalized in last 5 years; Indicator: 0 = no; 1 = yes	E
Mental health	Score on Mental Health Inventory 5; range 0 – 100 (=healthy)	
Limited in daily activities	Only for individuals who reported to have a chronic condition: 0 = not limited; 1 = mildly limited; 2 = severely limited	E E
ADL disability	0 = not disabled; 1 = mildly disabled; 2 = moderately disabled; 3 = severely disabled	E
Mobility disability	0 = not disabled; 1 = mildly disabled; 2 = moderately disabled; 3 = severely disabled in	

[a] Follow-up period of survival in population models is 3 year; in extended homecare model 2 year

[b] ADL items: eating and drinking, (un)dressing, washing hands and face, washing oneself completely, transfer from chair

[c] Mobility items: moving indoors, moving outdoors, walking stairs, transfer from bed, entering/leaving room

[d] Covariate is included in: P = population model; E = extended homecare model

Appendix B Estimates of covariate effects on likelihood of total LTC, institutional and homecare use and expenditures

Covariates	Total LTC		Institutional LTC		Homecare	
	Probit	GLM	Probit	GLM	Probit	GLM
Male	-0.284 (0.124)*	-0.053 (0.047)	0.431 (0.221)	29.084 (2.706)***	2.075 (0.124)***	-0.642 (0.253)*
Age	-0.0846 (0.019)***	0.020 (0.007)**	-0.220 (0.034)***	-11.023 (2.690)***	-1.412 (0.019)***	0.068 (0.037)
Age^2	0.011 (0.000)***	-0.000 (0.000)***	0.003 (0.000)***	0.131 (0.036)***	0.020 (0.000)***	-0.001 (0.000)**
Age^3	-0.000 (0.000)***	0.000 (0.000)***	-0.000 (0.000)***	-0.001 (0.000)**	-0.000 (0.000)***	0.000 (0.000)***
Male * Age	0.004 (0.003)	0.004 (0.001)***	-0.004 (0.006)	-0.422 (0.032)***	-0.064 (0.003)***	0.016 (0.007)*
Male * Age^2	-0.000 (0.000)***	-0.000 (0.001)***	-0.000 (0.000)	-	0.000 (0.000)***	-0.000 (0.000)**
Alive after 3 years	-2.099 (0.032)***	-0.183 (0.010)***	-2.081 (0.043)***	-23.071 (2.856)***	-2.840 (0.032)***	-0.357 (0.055)***
Time-to-death	-0.037 (0.002)***	-0.001 (0.000)	-0.025 (0.002)***	0.035 (0.067)	-0.024 (0.002)***	-0.008 (0.003)**
Time-to-$death^2$	0.001 (0.000)***	-0.000 (0.000)	0.000 (0.000)***	-0.007 (0.002)***	0.000 (0.000)***	0.000 (0.000)***
Living alone	0.616 (0.023)***	0.108 (0.007)***	1.312 (0.036)***	-	0.491 (0.023)***	0.453 (0.041)***
Alive * male	0.058 (0.016)***	0.021 (0.004)***	0.091 (0.019)***	3.245 (1.114)**	-0.006 (0.015)	0.042 (0.025)
Time-to-death * male	-0.008 (0.001)***	0.000 (0.000)	-0.006 (0.002)**	0.325 (0.113)**	-0.012 (0.002)***	-0.000 (0.003)
Time-to-$death^2$ * male	0.000 (0.000)**	-0.000 (0.000)	0.000 (0.000)*	-0.007 (0.003)*	0.000 (0.000)**	0.000 (0.000)
Alive * age	0.022 (0.000)***	0.002 (0.000)***	0.020 (0.000)***	0.287 (0.032)***	0.033 (0.000)***	0.002 (0.001)***
Alive * living alone	0.021 (0.016)	0.002 (0.004)	0.037 (0.019)	-	0.046 (0.015)**	0.019 (0.024)
Time-to-death * living alone	0.017 (0.002)***	-0.002 (0.000)***	0.001 (0.002)	-	0.020 (0.002)***	-0.002 (0.003)
Time-to-$death^2$ * living alone	0.000 (0.000)***	0.000 (0.000)**	0.000 (0.000)	-	-0.000 (0.000)***	0.000 (0.000)
Living alone * male	0.316 (0.004)***	-0.006 (0.001)***	0.130 (0.007)***	-	0.317 (0.004)***	0.074 (0.008)***
Living alone * age	-0.006 (0.000)***	-0.001 (0.000)***	-0.015 (0.000)***	-	-0.006 (0.000)***	-0.004 (0.000)***
Cause-of-death (ref: external)						
Neoplasm	-0.097 (0.016)***	-0.057 (0.004)***	-0.346 (0.018)***	-6.349 (0.994)***	0.033 (0.016)*	-0.135 (0.025)***
Diabetes	0.438 (0.021)***	0.031 (0.005)***	0.322 (0.023)***	4.288 (1.197)***	0.261 (0.020)***	0.182 (0.031)***
Mental	0.758 (0.020)***	0.120 (0.005)***	1.001 (0.020)***	27.051 (1.038)***	-0.132 (0.018)***	0.161 (0.029)***
CVD exclusive CVA	0.021 (0.016)	-0.001 (0.000)	-0.055 (0.018)**	2.365 (0.969)*	0.057 (0.016)***	0.007 (0.025)
CVA	0.227 (0.018)***	0.052 (0.004)***	0.319 (0.019)***	11.375 (1.032)***	0.044 (0.017)**	0.113 (0.027)***
Disease respiratory system	0.443 (0.017)***	0.041 (0.004)***	0.348 (0.019)***	10.276 (1.000)***	0.239 (0.017)***	0.130 (0.026)***
Disease digestive system	0.171(0.019)***	0.023 (0.005)***	0.095 (0.022)***	9.652 (1.188)***	0.114 (0.019)***	0.041 (0.029)
Other	0.311 (017)***	0.055 (0.004)***	0.363 (0.019)***	11.180 (0.994)***	0.087 (0.016)***	0.188 (0.026)***
Intercept	19.214 (0.455)***	1.498 (0.163)***	2.876 (0.868)***	421.489 (66.597)***	31.602 (0.452)***	2.845 (0.900)**
Power function (GLM link;fixed)		0.068		0.446		0.157
N	4039085	554292	4039085	141233	4039085	462431
Pseudo R^2 / Deviance	0.330	1160672	0.333	121445	0.260	667430

(*), (**), and (***) denote statistical significance at the 5%, 1% and 0.1% level respectively. Standard errors are in parentheses

Appendix C Estimates of covariate effects on the probability of and expenditures on homecare

Covariates	Homecare	
	Probit	GLM
Socio-demographic characteristics		
Male	-1.203 (0.711)	-0.304 (0.500)
Age	0.059 (0.066)	-0.015 (0.045)
Age^2	-0.000 (0.000)	0.000 (0.000)
Male * Age	0.008 (0.010)	0.002 (0.007)
Alive after 2 years	0.536 (0.377)	-0.307 (0.265)
Time-to-death in months	-0.048 (0.024)	0.007 (0.018)
Living alone	0.406 (0.094)***	0.040 (0.061)
Male * Living alone	0.781 (0.160)***	0.325 (0.120)**
Socio-economic characteristics		
Education (low = 0)		
Middle	0.077 (0.083)	-0.084 (0.057)
High	-0.212 (0.127)	0.044 (0.097)
Income (logged)	-0.299 (0.092)**	-0.065 (0.057)
Health status indicators		
Self-reported health (very good = 0)		
Good	0.115 (0.156)	-0.426 (0.271)
Fair	0.209 (0.173)	-0.277 (0.277)
(very) Poor	0.202 (0.209)	-0.260 (0.287)
Respondent has chronic condition	0.003 (0.143)	0.119 (0.122)
Mental Health Score	-0.002 (0.002)	-0.001 (0.002)
Previous hospitalization	0.436 (0.085)***	-0.079 (0.069)
Disability status indicators		
Limited in daily activities (no = 0)		
Mildly limited	0.347 (0.147)*	0.045 (0.124)
Severely limited	0.504 (0.145)**	0.075 (0.131)
ADL (not disabled = 0)		
Mildly disabled	0.130 (0.107)	0.115 (0.077)
Moderately disabled	0.526 (0.182)**	0.214 (0.105)*
Severely disabled	0.737 (0.229)**	0.901 (0.133)***
Mobility (not disabled = 0)		
Mildly disabled	-0.055 (0.109)	-0.076 (0.085)
Moderately disabled	0.380 (0.138)**	-0.040 (0.094)
Severely disabled	0.499 (0.200)*	0.006 (0.107)
Intercept	-2.360 (2.544)	4.410 (1.780)*
Power function GLM (link; fixed)		0.157
N	4139	374
Pseudo-R^2/Deviance	0.383	394

(*), (**), and (***) denote statistical significance at the 5%, 1% and 0.1% level respectively. Standard errors are in parentheses.